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WHAT WE MAY HOPE FROM THE GENERAL SCIENCE COURSE.[1]

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From the standpoint of theory, plasticity of the mind is very much to be desired in education. Our professional and our non-professional critics of education plead for open-mindedness and a training in thought processes which, with practice, shall carry on through our lives, and yet our present practice is quite far from producing this ideal we hear discussed in this forum on education.

All of us believe that personally we are broad-minded and that we sincerely desire our young people to be so taught that they will be alert in their thinking on present day problems but still if one of our high school teachers ventures to discuss some social problem that has arisen since the Revolutionary War, he is quite likely to be censured severely. He may discuss such a question as "Who was the greater Patriot—George Washington or Paul Revere?", but if he permits his pupils to discuss prohibition—The Teaching of Religion in the Schools—or some pressing political question, many of us are ready to stop him. Some one calls the local newspaper and tells the editor of this case of unbelievable heresy. As a result, this ambitious seeker after truth is properly cuffed until he is quite willing to stay within the limits of the conventional "dry-kilned" curriculum. His enthusiasm is stultified, and he gradually reaches the place where he is willing to go along, keep his skirts reasonably clean and get through life.

In practice, we say that we must not discuss with our pupils the practical problems of religion, politics and government. We have changed rather slowly in these fields, probably because the ultimate truths in these fields are not so easily demonstrable as in the fields of science, and our residual prehistoric natures

[1]Read at the General Session of the November meeting of the C. A. S. and M. T., at the University of Chicago.

stiffen and balk at most attempts to change our centuries old inherited ideas concerning these things.

The pioneers in any field must be a hardy lot. To be successful in their work, it is necessary to be alert to the situations which are likely to obstruct their progress and also to be alert to the advantages which they from time to time acquire. After the period involved in successful pioneering, there comes the period when the work is much easier than before. Many ready-to-use solutions are available and much less thinking is required. The solutions seem good enough. Ideas begin to congeal. This happens in all fields of endeavor. When the ideas of a business concern have congealed the business is doomed. Most any of us can think of a list of casualties of this sort. The management grows older and refuses to consider new systems and new processes, and in a few years the competition of other concerns whose ideas are still in liquid or gaseous form puts them out of business. This is as it should be. We cannot stop progress if we would. The same illustration may be applied to civilization; the period of life of a civilization will be in inverse ratio to the extent to which the congealing process has gone.

Now we pretty generally agree that our educational process is at the heart and also furnishes the hope for keeping our progress positive. It is rather trite to say that education is the base of civilization. We don't agree always as to what education shall be. I suppose that every one has a philosophy of education whether he has labeled it by that term or not. Education is discussed universally by the professional as well as the non-professional critic. Often excellent educational ideas spring from those who are but casual thinkers on the subject. Many school administrators are so busied with the details of their work that they actually have no time to think about education. As a result they must "muddle through." They have no definite or constructive beliefs, and as a result are willing to permit their mild opinions to be "denatured" to fit in with what seems to be the consensus of opinion—the middle ground. These administrators are the legitimate prey of the propagandists and fanatics.

This is a rapid fire age We are so anxious to escape from the accusation of dullness that we permit our minds to skip over so many things that rarely are there sufficient facts bearing on one subject to furnish the basis for a thought. They say the dogs along the Nile drink as they run to escape the crocodile. We skim through the papers to get the current news, most of which

will be valueless tomorrow. We listen to luncheon speeches, scan some more news and later tune in on several types of broadcasting.

Our schools are affected by this tendency, of course. In my opinion, we have been permitting entirely too wide an election of courses in our junior and senior high schools, and probably in our colleges of liberal arts. The diffusion which we have had leads to a futile dissipation of thought and an instability which should be avoided. We have permitted our young people to take half-year courses in subjects to get a half-year of credit. After they have finished the course and taken the examination, the information, if any, gleaned from the course may be pigeonholed. It isn't a prerequisite to any other course, nor is it a part of a sequence which fits into the plan of the pupil's education. We have even thought that we must have a number of such courses to enable pupils to fill up the deficiencies in credits required for graduation. I am thinking particularly of our high schools. However, the liberal arts colleges are by no means free from this criticism. In the junior high schools we have put in a number of so-called try-out and exploratory courses in which a mediocre teacher takes a pupil for a semester or in some cases for just a period of ten or twelve weeks, to find out whether the pupil has any particular aptitude or liking for that kind of work. In many cases the teacher is quite inexperienced and wouldn't discover the aptitude if the pupil had it. In some cases, the pupil may acquire a hatred for the subject because of the superficial presentation, or he may acquire a fancied liking for the subject out of all proportion to other subjects because of the personality of the teacher.

Isn't it about time that we qualified as, and considered ourselves as, experts in this profession and reached some conclusions concerning some of our problems instead of permitting ourselves to be pushed hither and thither because we do not believe anything very strongly concerning the philosophy of our profession or concerning the application of it to our practical problems. We take a middle ground so that we may step aside easily in case of controversy.

However, we shall not be considered the experts in our profession unless we do reach decisions and know why we are reaching them. We are letting the pupils determine the answers to many questions which we, from our point of vantage, should be answering for them.

We talk a great deal about teaching pupils to think. Admit that this characteristic is what we desire most. People do not think to much purpose with just a smattering of knowledge. Superficiality doesn't produce worth while thought. We cannot think without facts. Information must be the basis of thought. Our elementary education is probably as good as any in the world, if not the best, but there is a serious question when it comes to our secondary education. Secondary education is, by no means, so universal in England, France, and Germany, but it is probably much better for those who take it. It is much more thorough. There are few or no electives in the several types of schools. There is a sequence of subject matter in any particular course which carries through the period of school life. Of course we have the argument that we are educating a much larger proportion of our population in the secondary school. But we have averaged down in taking in this great group of pupils. Is it necessary? Our democratic ideals insist that all pupils shall have equal opportunity in education and our interpretation of equal opportunity has permitted many pupils to be placed in courses which contributed but slightly to their needs. We have not been able to differentiate subject matter rapidly enough to meet the demands of our rapidly increasing high school population, and as a result, our more intelligent pupils have in most cases not been kept working up to anywheres near their capacity. This is a serious defect. Whether we admit it or not, we all believe in an aristocracy of brains. It is definitely a part of our evolution of civilization, and it will apply regardless of who gets in its way.

Science has developed very rapidly in the last century. The progress during the last three decades has been astounding Those who were watching its development hoped and sometimes predicted that education would be much benefited or stimulated by the advent of more science into the curriculum. Most of us have been mildly disappointed. Possibly we were expecting too much. Our social development has not kept pace with our technical skill. Science has not fitted into the scheme of education as thoroughly as we had anticipated and likewise education has not accepted and promoted the purposes of science to the extent that some think it should. Possibly the hopes were not well grounded when considered in the light of a safe rule of progress. The growth of knowledge and the practical applications of it have been epoch making in scope; still science teaching has failed

to meet our expectations either as an integral part of our education or as a means of developing a desire for a consequent spreading of science. It is the scientist teacher who logically must raise the question and ask himself what the trouble may be. As an institution, education probably will change rather slowly. Thought meets and solves the problems arising in the various new situations that life encounters. We set up a scheme of education recognizing those solutions only to discover that the problem solving has gone on and we are still a half generation behind. Ideals must constantly be wrecked to make way for new ones.

Our objectives in education haven't changed a great deal in a number of years. We still think that Spencer stated them pretty well. This being true it should be relatively easy for us to draw the plans and specifications for producing the product. Well, you say, "What is the answer?" How would you proceed to lay the plans which will produce the result that you are hoping for? In the first place, I would reduce the number of electives. There should be a continuity of subject matter from the grades through the high school. Language, mathematics, science, the social studies, music, art and the vocational studies would, in general, be continued, through the twelfth year after they were once begun. I would do away with all of the educational waste baskets by which I mean special courses not designed to meet the actual needs of pupils, but to furnish a place for them to sit and not do much harm to the other pupils. We certainly can adapt educational materials to fit the needs of these pupils.

The school, as an institution, is designed to preserve and transmit those elements in progress which have stood the test of time and which contribute most effectively to what we consider the major objectives of education, and also the school as an institution is designed to give to our pupils a training in logic which will enable them to fit into society as leaders or intelligent followers as the case may be.

We have in science an instrument for restating truths, for eliminating the fears due to ignorance and prejudices, for challenging convictions and for disproving errors. In other words, we have in science the most effective means of preserving the integrity of the purposes for which the school, as an institution, was designed. Science cannot come into controversy with the avowed purposes of education.

The spirit of science and the purposes of the school as an institution are in strict accord. There is doubtless in our schools an

institutional lag behind the development in a number of the fields in which we attempt to give instruction. The commercial courses will rarely be found to be in step with the practice in the most progressive business concerns. The courses in social studies will probably be spending too much time with a study of decadent practices. The science taught may not open up the latest discoveries or theories of the subject, but the spirit of the sceienc teaching can always be such as to contribute strongly to openmindedness, sincerity, logical reasoning and a desire and acceptance of truth.

This spirit that we so much desire can best be attained if we are to have the very best material. The very best subject matter possible for the beginning work is the subject. Nearly everyone, educators included, when discussing the subject in the abstract will agree that we need much more science in the curriculum from the elementary grades through the high school, but still its progress is slow.

Science is rarely found in our elementary schools. If it is found, it is likely to be entirely made up of nature study, and while I believe that there should be a great deal of nature study in the earlier years, I believe most strongly that the more exact physical sciences have been sadly neglected in these years. There are many questions that should be answered in these years. If they are not answered when the wonder—when the question arises in the child's mind, they probably never will be answered. The wonder is gone by the time the individual has reached adult life, and although he doesn't know the answer to the question, he has learned that he can get along without knowing it, and his curiosity no longer drives him to seek new knowledge. Questions of this sort multiply in the mind of the individual in geometric ratio, if answered, and we should strive to keep alive the inquiring attitude which is so common in our children and which is so rare in older people.

There is a time in our lives when we want to know why a match bursts into flame when we "strike" it. The time when we want to know is the time when the question should be answered. After a while, the child learns that it doesn't pay to wonder. He never gets the answers. He doesn't much care why the march "lights," and we have lost a most valuable factor in teaching or learning as the case may be.

We recently conducted a little study in the Cleveland School of Education with the idea of discovering the extent to which

individuals who were in our schools or were the product of our schools were interested in and able to answer the common problems of their environment. A long list of questions which children commonly ask was collected, and from this list twenty-five questions were selected. They were selected on the basis of the number of times they appeared. The validity of the choice was further checked by 300 people who were asked to state whether the question had ever occurred to them. Then the questions were given to a group of junior high pupils, senior high pupils, junior college pupils and teachers. I just want to stop long enough to give you the results of the answers to the question. "Why does oil float on water?" 24 per cent of the junior high pupils answered the question incorrectly, 24 per cent of the senior pupils, 53 per cent of the junior college pupils answered incorrectly, and 24 per cent of the teachers. The teachers were more versatile in their answers, however. "Oil floats on water because it is heavier"; "because oil and water will not mix"; "because oil is greasy," were types of incorrect answers given by the teachers. Now, my only point is this—Age of the individual has very little to do with his ability to answer the common questions that arise in childhood. The questions were collected from all grades. You would agree, I believe, if I were to give you the entire list of questions, that most of them could be answered satisfactorily to pupils in the elementary school range. Why not answer these questions when they are vital and teeming with interest?

We are attempting a beginning in the solution of this problem by putting a science course in the Cleveland schools from the kindergarten through the high school. It is elective only in the senior academic and commercial high schools. However, if the science is well enough taught in the elementary grades, it may be able to take care of itself in the higher grades, and I am hoping that we may require more of it in the higher grades before long and to create a greater demand for its teaching. Possibly we shall be able to reduce the number of electives in the high school and prescribe more definitely the program of studies that should be followed. In our technical high schools, science is required throughout the course.

The course we have prescribed for the elementary grades is very strong in nature study and elementary biology and correspondingly weak in the physical sciences. But it is a beginning, and we shall be able to vary the course as we go along.

Now, where shall we get teachers for this work. They do not exist at the present moment, but are in the process of being developed, and they must be developed along with the course if it is to succeed. The teachers are meeting in groups once a week with a capable instructor to discuss subject matter, and its adaptation to the different grades of pupils. With us, it is an experiment in the final result of which we have confidence. I believe that the teachers who are doing the work share this faith. The best way to develop teachers is to interest them in curriculum problems. Every teacher in this group is a member of a committee responsible for the development of the course of study in at least one grade. The course is mimeographed and subject to change without notice. We hope to keep it in liquid form for a while at least.

I have already said that if we are to have more science in the courses of study, and if we are to obtain better results with the science that is taught, our teachers of this subject must be vitally interested. It hasn't been many years since our science teachers were voicing serious apprehension over the advent of general science into the program of studies. The physics teacher was afraid that the "edge" would be taken off the approach to his subject by the smattering that the pupil would get in the ninth year course in general science. The chemistry teachers and the biology teachers were voicing disapproval for the same reason. I do not believe that these arguments are considered valid at this time. There is certainly plenty of science to be taught and if our courses are well adapted to the age and capacity of the pupils, a sequence in science cannot but stimulate the interest of the pupil in the subject matter, increase his enjoyment in his sense of achievement and accomplishment, and contribute in a positive way to the attainment of the immediate objectives of the complete science course and the general objectives of education.

We may assume our methods of teaching the limited amount of science which we find in our curriculum to be fairly good. The laboratory and demonstration method apparently is giving excellent results although we are not in agreement as to the relative values of the laboratory method where the pupil performs the experiment as compared with the teacher demonstration method. Apparently we are not quite sure of our ground as we go lower in the grades. We are not quite sure, for example, how much of the laboratory work may be profitably done by

the pupil in the ninth grade, the seventh grade, the fifth grade, and so on down. If we cannot get the time for pupil laboratory work in these grades, I believe that we shall agree that we may be able to get along quite well without individual laboratory work, leaving most of such work to be performed by the teacher. Our friends in Europe are envying our well equipped laboratories for pupils, but they are not willing to exchange their curriculum organization in science for ours.

America furnishes countless examples of her dependence on science. We hear on every side that this is the age of science. We come into contact daily with a wide variety of the applications of science. Still we find it pretty well croweded out in our system of electives in the higher grades. Our educators do not yet believe in science as an integral non-replaceable part of our curriculum, However, I am assuming that they will, in time, and it is our duty to hasten that time as much as possible by having the very best organization of material to go into these courses for the several grades in which it is to be taught. I don't know why, but there is still a great deal of difference of opinion as to what science shall be taught. This teacher would have a great deal of biological science and the next teacher would emphasize the physical science to the exclusion of the biological science. I do not suppose that it makes a great deal of difference which science is taught if the pupil is only going to have one year of science, provided that during that year he be well taught. However, if we are to have more science in our lower grades, I am of the opinion that we should have more of the physical sciences than we find in most courses. We live in an environment in which the laws of physics are fundamental. The biologist must know physics if he is going far into the subject. The engineer must begin with a knowledge of the principles of physics. The home has all sorts of appliances involving a knowledge of mechanics—heat, electricity, sound and light. Physics is recognized today as the science which touches life most closely. It is the science which one should know something about if a choice must be made. I am hoping that our curriculum may be so organized, however, that we shall not have to make that choice and I am only making the statement to argue that in our elementary science courses, regardless of the grade in which the beginning is made—first, second, third, fourth, fifth or sixth—the physical science shall not be neglected as is so often the case.

Recommendations

1. The elementary science course should be organized for and taught in all grades, first to ninth, inclusive.

2. The course should include biological and physical science, involving the pupils' environment and adapted to the grade in which it is to be taught.

3. In the seventh, eighth and ninth years, the balance should be strongly on the physical science side.

4. The sequence in the 10th, 11th, and 12th years should be biology, chemistry-physics.

The general aims in the first nine grades should be:

1. To stimulate the child's interest in nature and his appreciation of his environment.

2. To help the child to care for himself and to solve his own problems.

3. To cultivate his powers of observation, judgment and reasoning.

4. To give the child training in the use of the scientific method of solving problems.

5. To interpret the life about him.

6. To train the child in the organization of his common experiences so that he shall make a better use of them and to provide him with some opportunities for practice in applying knowledge already gained to the solution of new problems.

7. To foster in the child a confidence in the knowledge he gains by the scientific method.

8. To develop in him a logical attitude toward his social and physical environment.

SCHOOL NURSE ADMINISTRATION IN AMERICAN COMMUNITIES.

Employment of a school nurse in a community adds point to health teachings in the schools. The number of cities in the United States employing nurses has more than doubled in the past 10 years, and the proportionate figure for rural schools is even greater. No uniformity has yet been reached as to terms of contract or duties required of the school nurse, but in 116 out of 179 cities having a population of 30,000 or more, from which information could be obtained by the Interior Department, Bureau of Education, as reported in School Health Study No. 11, the nurse is employed for the school year, and in 58 for the calendar year. The average number of children per nurse is about 3,000, varying from 800 to as many as 7,000. In some cities the applicant must stand examination, in others a certificate as registered nurse is required. The salary ranges from $637 to $2,700. In 110 of the cities sick leave with pay is granted, in 102 vacation with pay, and benefit of the retirement fund in 41. —*Department of Interior.*

ILLINOIS COAL AND THE NEW ILLINOIS WATERWAY.[1]

An investigation of conditions that will affect the transportation of coal on the proposed new Inland Waterway, with special attention to the Chicago Switching District, the chief consumer of Illinois coal.

By Esther W. Utzig,

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Coal consumers in Chicago are looking forward to the new Illinois Waterway to provide a means of cheap transportation of southern Illinois coal from tipple to factory. Some definite progress has been made on this Waterway which will connect the Illinois River with Lake Michigan. Eventually, it will connect two of the world's greatest inland waterway systems, the Mississippi and the Great Lakes-St. Lawrence. It is properly called the Great Inland Waterway System.

The section of it which concerns Illinois will occupy the Des Plaines and Illinois Rivers between Lockport and La Salle, Illinois, a distance of approximately 63 miles. Five locks and dams which will cost $20,000,000 are to be constructed at the following points: Lockport; Brandon Road at the southwest limits of Joliet; Dresden Island below the mouth of the Kankakee River; Belle Island two miles east of Marseilles; and Starved Rock.

From Starved Rock to La Salle, the Illinois River will be dredged to an eight foot depth, and it is expected the present seven foot depth of the Illinois River will be dredged to a depth of eight or nine feet between La Salle and the Mississippi River by the Federal government. The present locks and dams in the Illinois River will be removed since they will not be needed, provided the present diversion into the Chicago Drainage Canal of 10,000 cubic feet of water per second from Lake Michigan is continued.

The question arises, "What will the Illinois Waterway do for the state to justify this expense of $20,000,000?"

Of the commodities which will be affected by the Waterway as a means of transportation, the only one we are interested in here, is southern Illinois coal and the reported benefits of the Waterway to its cheap transportation. Let us investigate the trend of coal production in Illinois and estimate approximately the amount of coal which will be available for transportation by the Illinois Waterway.

[1]Acknowledgments are due to Professor W. O. Blanchard of the Department of Geology for suggesting the problem and offering valuable criticisms.

Continuous records of Illinois coal production for fiscal years ending in June, from 1881 to 1923 inclusive, are available. These show (Fig. 1) that a maximum increase in production was attained in 1918 during the war period, and the anticipated re-

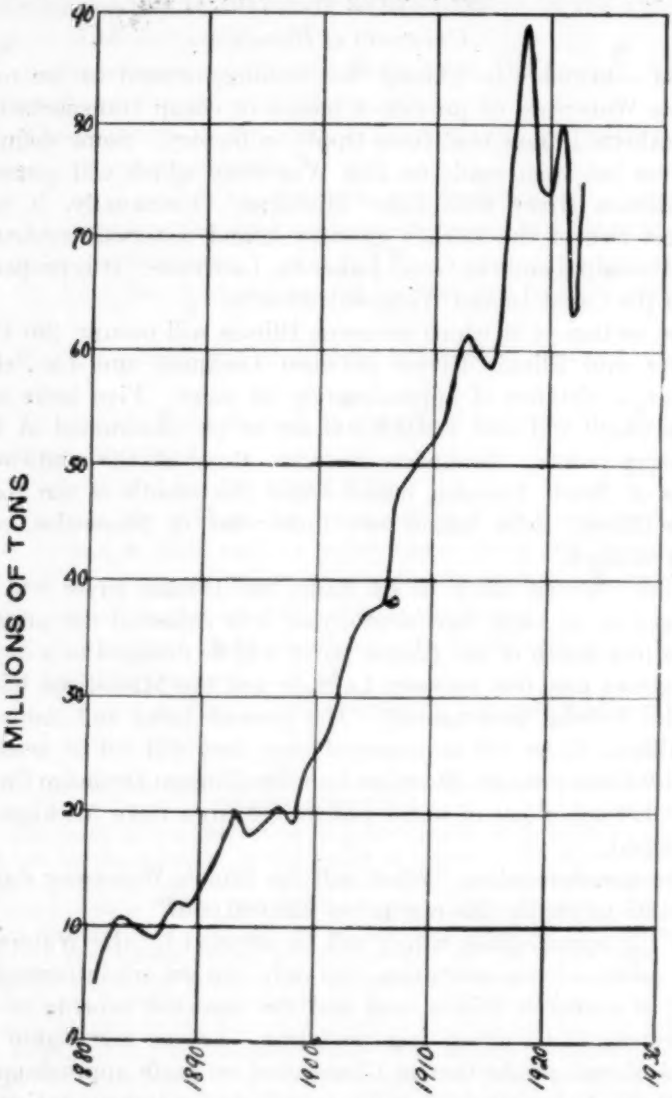

FIG. I. DIAGRAM SHOWING COAL PRODUCTION IN ILLINOIS 1881-1923.

action came in 1919 following the armistice. The Illinois coal miners' strike of 1922 accounts for the low point of production in the state during the last decade.

Illinois produces twice as much coal as she uses, and all but one-fifth that she consumes is Illinois coal. No other important coal-producing state consumes so large a proportion of its annual production essentially within its own borders and exports so small a proportion.[2] When the Waterway is completed, how much coal will be directly available for water transportation on the main waterway? No definite figures are available to indicate how much coal will be shipped in this manner.[3]

In 1923, only 16,655 tons of coal from the Lancaster Mine in Peoria County, situated three-fourths of a mile from the Illinois River, was shipped by boat; the rest of the output was transported by rail.[4] The Lancaster Coal Company uses the Illinois River for two reasons. One is that they have no rail connections closer than four miles, and the other is that their business is that of supplying steam boats, dredges, the pumping plants of drainage districts, and towns that have no rail connections.[5]

Although we cannot know the production of mines along the Waterway in the years to come, nevertheless, we can form some estimate of the amount available in the future, by getting the total of the present production of all mines within a short distance,—let us say one mile,—of the Waterway.

The accompanying graph (Fig. II) shows the production of these coal mines within one mile of the Illinois River, compared with the total production of Illinois coal for the same years. The average annual production of all these mines is 1,500,000 tons. As can readily be seen, this amount directly available for water transportation on the Illinois Waterway is insignificant, in comparison with the average annual production in the whole state. It does not seem probable therefore that the Waterway in its present proposed form will afford any of the large coal fields in southern Illinois a cheap means of transportation.

Mr. William L. Sackett, late superintendent of the Division of Waterways of the State of Illinois, has recommended the development of the Big Muddy River in southern Illinois as an aid to opening up coal fields of this section through providing transportation of coal by water to Chicago. The problem of moving coal from mine to market has been receiving increasing attention in this area of recent years because of the rapid increase in the number of mines and their increased output of

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[2]O. H. Barrett; Mineral Resources in Illinois.
[3]Letter from R. W. Putnam, Major Corps of U. S. Engineers, Feb. 5, 1925.
[4]Illinois Annual Coal Report, 1923, p. 60.
[5]Letter received from Lancaster Coal Co., Feb. 5, 1925.

bituminous coal of an excellent quality. The total production of Franklin, Williamson, Jackson, and Perry counties has increased from twenty-one in 1910 to thirty-four per cent of the

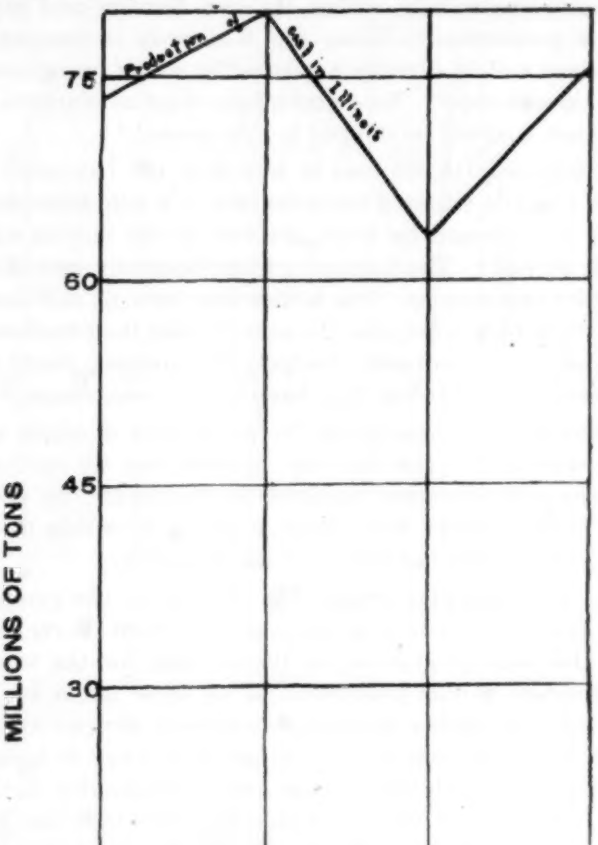

Fig. II. Production of Illinois Coal compared with Production of Mines One Mile from the Main Channel of the Illinois River and the Big Muddy System.

state output in 1923. The production of all the mines within a belt ten miles wide,—five miles on each side of the Big Muddy

River in these four counties,—would have practically all of the 1921 production of 17,500,000 tons available for water transportation, if the river were improved.[6] This is twenty-one per cent of the production of Illinois for 1921.

By the same method as that used for the figures for Illinois River traffic, an estimate was made of the amount of coal which will be available for water transportation from mines within one mile of the main channel and branches of the Big Muddy. The average total annual production of these mines for the four-year period, 1920-1923, is 10,000,000 tons.

Thus a very rough estimate of 11,500,000 tons may be made for the amount of coal available for water transportation produced near the Illinois and Big Muddy Projects.

Let us compare the cost of moving a ton of coal by water with the cost of transportation by rail.

The detailed cost of transportation of one ton of coal by water is as follows:[7]

Mine to river by rail, 40 miles at .8 mills	$ .32
Loading barges from tipple	.02
Tipple to Chicago by water 400 miles at .6 mills	.24
Unloading at Chicago	.10
Chicago to tipple, empty, 400 miles at .4 mills	.16
Insurance	.05
Margin for profit or contingencies 19 per cent	.20
Total	$1.09
Present Rail Rate	2.17
Savings per ton	$1.08

The rail charge[8] in the above is the average freight charge in Illinois. This estimate is based on transportation on the Illinois Waterway. Most of the coal will be moved from southern Illinois and if the Big Muddy is canalized, the cost of haul would be about double the cost per ton mile on the Illinois Water way, owing to the very much smaller locks and single shipment cargoes on the Big Muddy.[9]

The railroad charge is made on the basis of full payment for all service including cost of the road and maintenance. The waterway rate in no way provides for payment on the original investment or cost of interest or maintenance.

Conditions which control the cost of construction and maintenance of channels in natural or artificial waterways differ so

[6]Report of the Illinois Division of Waterways on the Big Muddy River.
[7]Report submitted by Illinois to the Senate Committee part I, page 128.
[8]Letter from M. G. Barnes, Chief Engineer, Illinois Division of Waterways.
[9]Letter from M. G. Barnes, Chief Engineer, Illinois Division of Waterways.

widely that no general equation of costs can be given. Costs on the recently completed New York State Barge Canal may be given for illustration of a specific case. The total capital cost

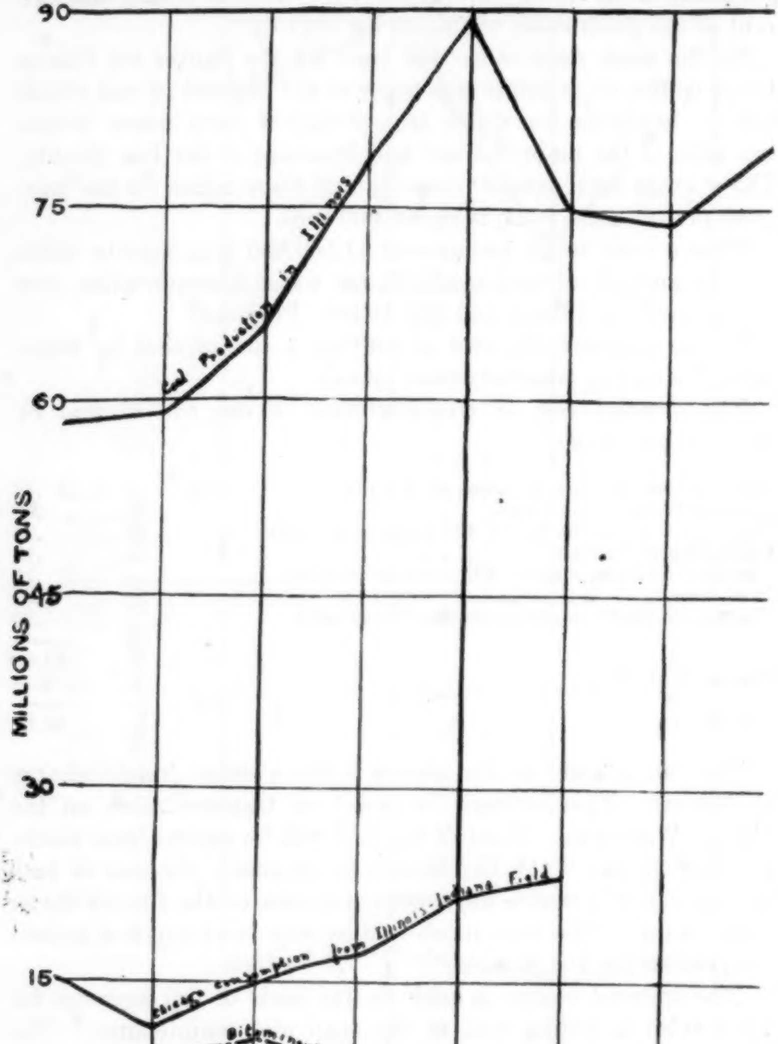

FIG. III. PRODUCTION OF ILLINOIS COAL AND SOURCES OF CHICAGO CONSUMPTION 1914-1922.

was $168,053,962.31, which gives at 4%, an annual interest charge of $6,722,158.49. The expenses of maintenance and operation in the fiscal year ending June 30, 1924, were $4,099,975.67. These altogether make a total annual charge against traffic carried by the N. Y. State Barge Canal of $10,822,134.16. This traffic in 1923 amounted to 2,572,635 tons, so the charge for interest and cost of maintenance and operation averaged $4.21 per ton.[10]

Chicago is unquestionably the largest consumer of Illinois coal which has access to the Waterway,[11] consuming approximately twenty-three per cent of the total average production in the State. The graph (Fig. III) shows the sources of coal consumed by Chicago from 1914 to 1919 inclusive. The consumption of anthracite coal has remained practically stationary, while that of bituminous from the Illinois-Indiana field shows an increasing consumption.

If Chicago's consumption of coal from Illinois is increasing, that does not necessarily mean all the coal will be transported to Chicago by means of the Waterway, since, as I have shown, the total production of mines near the Waterway and Big Muddy is approximately 11,500,000 tons of coal.[12]

It does not appear likely that Chicago will greatly increase her consumption of Illinois coal in comparison with that from eastern fields, since it is of a poor grade not suited to coking purposes. The Chicago By-Products Coke Company consumes 720,000 tons of coal annually, all of which is shipped by rail from the West Virginia and eastern Kentucky fields.[13] So far as known, commercial coke from Illinois coal is being made only by the St. Louis Coke and Chemical Company, where 80 per cent of Illinois coal is used with eastern coal.[14]

Attempts to coke Illinois coal in by-products ovens have been experimental. Illinois coke is light, and tends to shatter easily. Available tests indicate that for any given purpose, more coke from Illinois coal will be required than if coke from eastern coal is used. High sulphur and ash contents limit the use of Illinois coals for coking; manufacturers both of coke and of gas desire coals as low as possible in sulphur.

Even if we assumed that the greater proportion of this coal from Illinois which will be accessible to the Waterway after the

[10] Wat. & RW Equivalents: Disc. by C. H. Markham. Proc. of Am. Soc. of Civ. Eng., Feb., 1925.
[11] Letter from Major R. W. Putnam, Major Corps of Engineers, War Dept., Feb. 5, 1925.
[12] Dr. R. C. Honnold, Sources of Chicago's Coal Consumption.
[13] Interview with G. F. Mitchell, Vice-Pres. Peoples Gas, Light & Coke Co., Chicago.
[14] Interview with Prof. S. W. Parr, University of Illinois.

completion of the Big Muddy project and the Illinois Waterway, were sent to Chicago by water, it could not be unloaded right at the door of the factories as it can when shipped on the railroads. The railroads with their spur lines go to every part of Chicago, so that no transshipment is necessary as would be the case with water-borne coal.

Any handling of coal means breakage. To get coal from a mine by rail to a given waterway, to again unload from the boat into a railroad car for movement to ultimate destination, would mean a great deal of breakage and consequent degradation of the coal.

There are comparatively few industries located on rivers or present existing waterways in Chicago.[15] The Chicago By-Products Coke Company, located on the Drainage Canal and South Crawford Avenue, one of the large consumers of coal in Chicago, was not located on the Drainage Canal because it would have easy access to water-borne coal, but because the Canal supplied the large amount of water necessary in the manufacture of gas.[16]

Chicago has few facilities for unloading and storing water-borne coal. The entire water front from Calumet Harbor on the south to the northern limits of the city has now been given over to park projects. The Chicago and Northwestern Railroad has one spur track running over to within 1,000 feet of the Municipal Pier, but the cost of haul by truck from the Pier to the commercial center of Chicago is so great that the Pier will never be of use as a Chicago terminal, unless connected with railroads.

The Chicago River from Chicago Avenue on the north to 22nd Street on the south is now seventy-five per cent owned and controlled by railroads. The other twenty-five per cent is occupied largely by industries.[17] The portion south of 22nd Street is being filled and taken away from the water interests as rapidly as possible. The South and West Forks of the South Branch of the Chicago River were abandoned as navigable waterways by acts of Congress in 1923.

The only places available for handling of freight after having used the lake front for park purposes, and the Chicago River for railroad and other private industries, is a place south of Chicago known as the Calumet or Lake George district. The work of building terminals cannot be done for a few thousands;

[15]Letter from Dr. R. C. Honnold, Nov. 19, 1924.
[16]Interview with G. F. Mitchell, Vice Pres. Peoples Gas, Light & Coke Co., of Chicago.
[17]Putnam, Maj. R. W., J. W. Soc. End. S '23, Chi's need for a Comprehensive Water Terminal.

for example, it will cost the State of New York over $25,000,000 for their terminals on the New York State Barge Canal and it is going to cost Chicago and Illinois a large sum.

A climatic factor which is disadvantageous to the Waterway is the freezing during the winter months. It is said that on the average, the river will remain closed from the end of December to the beginning of March, a total of 70 days.[18]

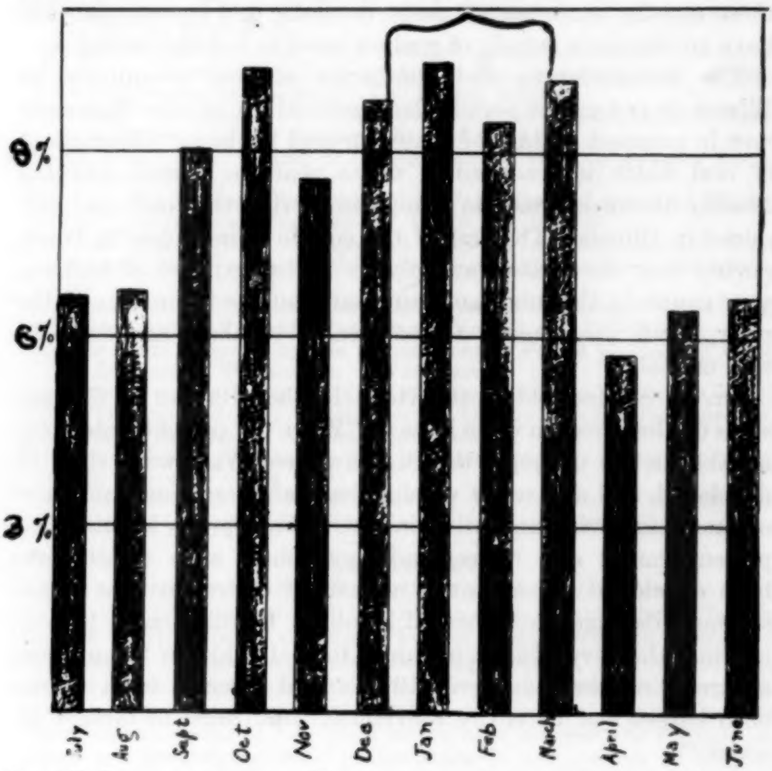

FIG. IV. DIAGRAM SHOWING PRODUCTION OF ILLINOIS COAL BY MONTHS IN PERCENT OF YEAR'S TOTAL FOR THE TEN YEAR AVERAGE 1914-1923.

The per cent of the coal tonnage produced each month for a ten year average, 1914 to 1923, is shown in the graph, (Fig. IV).[19] The two highest producing months are October and January, the latter being one of the months during which the Waterway would be closed by ice.

No matter how many canals were built from mines to the Waterway, either coal produced from the end of December to

[18]Cooley, L. E., Ice on the Illinois Waterway.
[19]Illinois Annual Coal Report, 1923.

the beginning of March would have to seek rail transportation, or the production during the ice-free months would have to be increased to care for the normal winter production in order to ship all coal to points of consumption for storage, before ice closed navigation. Thus the mines would be idle during the winter months unless coal were stored at the mines. It isn't possible that there will be no demand for coal production during these months, since not all users, domestic and commercial, will have an adequate supply of coal on hand to last the season.

The circumstances and conditions of coal production in Illinois do not as yet permit the beneficial use of any Waterway now in prospect within the state, for coal haulage. The amount of coal which is produced in mines near the Illinois and Big Muddy rivers is small in comparison with the total coal produced in Illinois. The rest of the coal in Illinois can be transported over the Waterway only by added expense of building spur canals to the mines, or using rail haulage from mine to the river, which would mean a great deal of breakage and degradation of coal.

Dr. R. S. Honnold of the Honnold Coal Bureau at Chicago sums up the situation when he says: "When our present waterways as well as, let us hope, the St. Lawrence Waterway, shall be developed, and as a result we shall have an increasing number of our manufacturing and other industrial enterprises located near present canals and rivers, and there shall as a result have been developed a substantial movement of freight that is not seriously damaged by repeated handling, it will then be time to consider the development of canals to coal fields for the purpose of providing the loading of Illinois coal directly from tipples onto barges and its entire movement from mine to factory by water.[20]

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ARBOR DAY

The celebration of Arbor Day will be given fresh interest in many states this year because of the national playground beautification contest which is being conducted by the Playground and Recreation Association of America. Recreation departments, playground committees, schools, park commissions, American Legion Posts, parent teacher associations, women's clubs, chambers of commerce, and other organizations in 179 cities which have entered the contest and which are beautifying their playgrounds in anticipation of winning national honor and cash prizes of either $100 or $550, are being asked by the contest committee to utilize Arbor Day as one of the most appropriate occasions for the beautification of their play fields.

With the current interest in improvement of play spaces, it is expected that many cities not competing in the contest will also select Arbor Day for the planting of trees, shrubs, vines and flowers about the school grounds and on play and athletic fields as a part of the general beautification movement.

On Arbor Day the special interest of the children will be enlisted by summoning them to do the planting or to engage in other beautification under the direction of a nurseryman or landscape architect. A ceremony, including a brief address on the meaning of Arbor Day, reciting of verses, songs, stories on noted trees, and dedication of the plantings may accompany the planting.

Arbor Day is celebrated at different times in different states, but the majority of the states have selected days in April or May.

THE REVISED NORMS FOR THE RANGE OF INFORMATION TEST IN SCIENCE.

By Elliot R. Downing,

University of Chicago.

In the January number, 1920, of School Science and Mathematics (Vol. XX, pp. 77-83) the author reported the score on the Range of Information Test based on returns from 529 high school students and other students both above and below the high school level. Since then the tests have been given to a much larger number of students and the norms can now be stated based on these additional returns.

The revised Range of Information Test consists of fifty words and phrases that stand for important concepts in science. They were selected from the common subject matter in a number of widely used texts in general science, physiography, physical geography, physiology, botany, zoology, biology, physics and chemistry, all at the high school level. It is a test in science in general, not in general science. The original list of words and phrases was revised on the basis of the judgment of some twenty high school teachers.

The instructions to the student on the test are to "mark with an E each word or phrase that you can explain or define, with an F those that are familiar to you but which you could not explain, and with an N those that are quite new. Define or explain the first five that you mark with an E." There is no time limit on the test but the students are asked to hand in their papers as soon as they are completed. When the brighter students begin to do so, the others hurry to finish. The test is usually completed in from six to ten minutes.

The number of words marked with an E is then counted and multiplied by two to give the pupil's score in percent. This is the uncorrected score and it is corrected on the basis of the definitions given. Thus if two out of five of the definitions are incorrect, the uncorrected score is reduced 40% to give the corrected score. A pupil is not held to scientifically accurate definitions, but if the explanation given shows that he has the idea, even if it is crudely expressed, it is accepted as sufficient.

In addition to the three high schools in which the test was originally given, it has now been given in ten more. The reports from some of these will appear later for reasons that will then be discussed. Selecting eight schools not including the three originally reported, the returns are as follows:

TABLE OF AVERAGES.

		Freshmen		Sophomores		Juniors		Seniors	
		No.	Score	No.	Score	No.	Score	No.	Score
Chicago High School	1	129	9.81	72	18.94	99	25.65	73	32.29
	2	142	11.29	84	12.38	78	24.09	48	35.33
	3	64	14.08	64	18.44	93	25.36	66	33.65
	4	52	10.54	22	27.77	29	24.97	27	29.70
	5	9	16.33	41	19.49	71	31.52	58	39.95
	6	143	12.57	81	17.88	47	26.25	21	42.88
Toledo High School	1	463	22.41	209	25.40	241	30.44	100	42.05
	2	305	16.37	106	20.40	82	25.80	60	33.20
All Chicago High Schools		539	11.62	364	17.70	417	26.35	293	35.15
All 8 Schools		1307	16.53	679	20.49	740	27.61	453	36.42

TABLE OF MEDIANS.

		Freshmen		Sophomores		Juniors		Seniors	
		No.	Score	No.	Score	No.	Score	No.	Score
Chicago High School	1	129	8.00	72	16.82	99	20.33	75	29.00
	2	142	10.22	84	8.55	78	22.14	48	30.43
	3	64	11.50	64	13.50	93	21.00	66	30.08
	4	52	8.50	22	20.00	29	22.00	27	27.22
	5	9	7.00	41	17.81	71	26.86	58	42.50
	6	143	9.00	81	13.52	47	32.00	21	38.00
Toledo High School	1	463	20.80	209	25.00	241	28.10	100	40.00
	2	305	14.50	106	17.00	82	23.00	60	29.00
All Chicago High Schools		539	8.84	364	13.80	417	24.82	293	32.00
All 8 Schools		1307	13.06	679	18.96	740	26.28	453	34.24

These norms are based on tests given to the pupils in the science classes at the end of the first semester in each year of the high school. To determine from these the probable norm for some other time of the year select the norm that is nearest in point of time to the date when the test is given. Add to or subtract from it for each month's difference in school year time one-tenth of the difference between it and the next adjacent norm. Thus in the earlier attempts at standardizing this test, the tests were given at the end of each school year. The average score of freshmen was then 17.50%. The difference between the freshman average for all high schools and the sophomore average on the present norms is 3.96%. Multiplying one-tenth of this by five and adding the product to the freshman average at mid-year, 16.53% and we get 18.51% which is fairly close to the end-of-the-year average given above. The score so obtained is probably more reliable than the 17.50% for it is based on much larger numbers.

By using these tests a principal can with fair probability decide how the efficiency of the science instruction in his high school compares with the average in these eight schools. The science teacher can use the test also to determine which pupils

in his class are the capable ones in science, which are the poorly prepared.

It is amazing to find what extremes of ability or preparation exist among the students in the same class. This will be apparent from the following table showing the range of the grades achieved by the pupils in the science classes of each school for each year.

TABLE OF THE RANGE OF THE GRADES ACHIEVED.

		Freshmen	Sophomores	Juniors	Seniors
Chicago High School	1	0—60%	9—74%	0—72%	0—96
	2	0—54	0—72	4—64	4—84
	3	2—44	0—80	2—78	0—76
	4	0—40	8—56	0—66	4—92
	5	2—48	2—50	4—94	0—74
	6	0—52	0—68	2—82	8—94
Toledo High School	1	0—74	0—80	4—92	4—90
	2	0—64	0—82	0—68	6—86

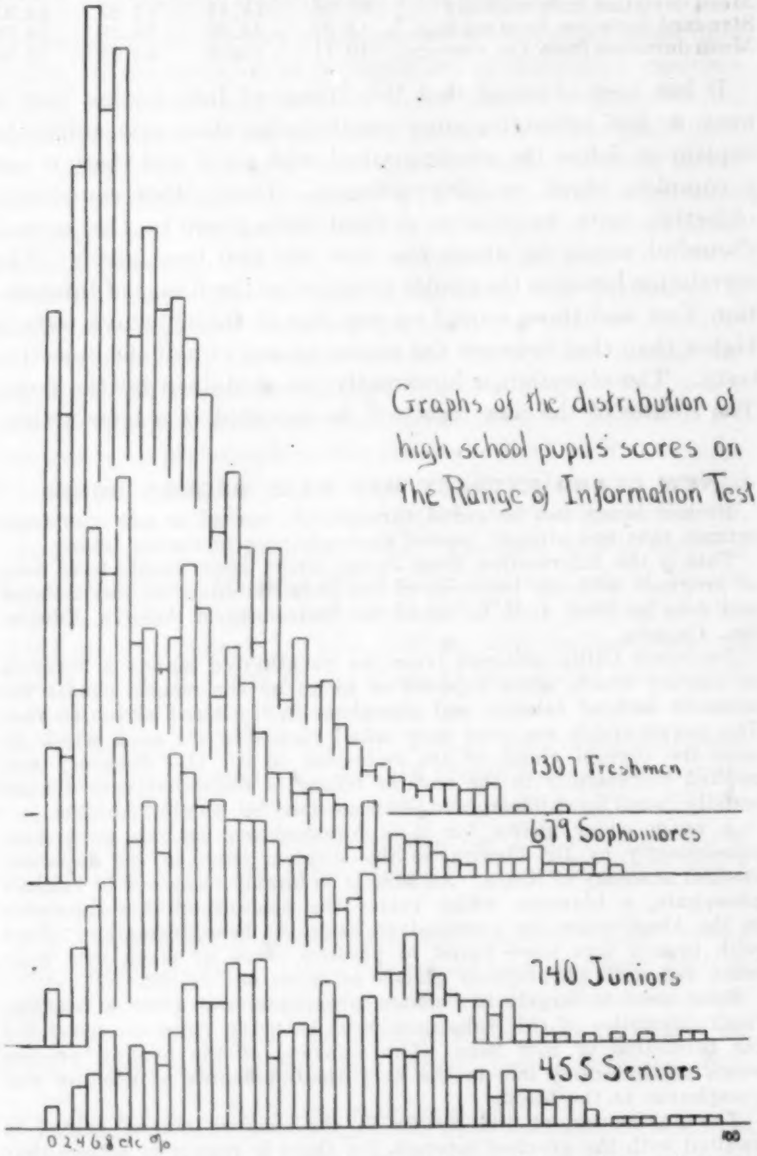
It is manifestly unfair to both pupils and teachers to try to give uniform instruction to a class composed of pupils of such widely variant ability or preparation in science. The tests might evidently be used to separate pupils into sections of more nearly the same capacity in order to fit instruction more perfectly to their needs.

The number of pupils who score the various percents from zero up is shown for each year of the high school in the following table:

NUMBER OF PUPILS SCORING FROM 0-100% OF E. (CORRECTED SCORES)
TOTALS OF THE EIGHT SCHOOLS

	Fresh.	Soph.	Junior	Senior		Fresh.	Soph.	Junior	Senior
0%	72	19	8	3	52%	4	5	16	10
2	57	18	4	....	54	3	5	7	11
4	93	27	14	6	56	4	3	10	16
6	113	51	20	8	58	4	2	7	7
8	101	44	23	14	60	3	1	6	7
10	110	58	44	8	62	3	....	6	8
12	68	34	29	12	64	4	2	4	4
14	84	36	35	11	66	....	2	6	8
16	72	30	27	9	68	1	2	2	5
18	74	35	42	14	70	....	4	2	5
20	68	45	39	21	72	....	1	1	3
22	60	39	34	18	74	1	1	1	4
24	40	26	35	18	76	....	1	....	4
26	49	33	32	24	78	....	1	1	2
28	38	28	32	22	80	....	2	....	....
30	24	21	32	24	82	....	1	1	1
32	38	15	29	10	84	....	....	....	1
34	16	15	26	14	86	....	....	1	1
36	25	12	27	15	88	....	....	....	....
38	18	13	18	14	90	....	....	....	1
40	19	12	23	21	92	....	....	1	1
42	13	10	19	16	94	....	....	1	1
44	10	4	21	12	96	....	....	....	1
46	6	11	24	19					
48	7	2	10	10					
50	5	6	10	11					

The distribution shown in the table is seen at a glance in the graphs that follow. Mere inspection of these shows that from freshmen to senior year the variation from the median is



increasing, or, in other words, that the science classes become less and less homogenious in preparation for the science work as we advance from the lower years of the high school to the upper. The amount of this increasing variability is expressed mathematically thus:

	Fresh.	Soph.	Junior	Senior
Average deviation below the median	−6.73	−9.29	−10.63	−13.27
Average deviation above the median	+14.50	+13.62	+15.47	+16.51
Mean deviation from median	10.08	11.11	12.87	14.85
Standard deviation from median	13.34	14.63	16.29	19.76
Mean deviation from the average	10.11	11.50	13.52	15.81

It has been objected that this Range of Information Test is more or less subjective since pupils judge their own ability to explain or define the words marked with an E and there is not a complete check on their estimate. Three other completely objective tests have been devised and given to the several thousand pupils to whom this test has also been given. The correlation between the grades achieved on the Range of Information Test and those scored on any one of the objective tests is higher than that between the grades on any two of the objective tests. The objection is apparently not sustained by the facts. The results of the new tests will be reported in a later article.

NEW GLAND EXTRACT MAY HEAL BROKEN BONES.

Broken bones can be cured through the use of a new glandular extract that has already proved its usefulness in curing tetany.

This is the information from Japan where experiments have been in progress with the hormone of the parathyroids that was isolated last year by Prof. J. B. Collip of the University of Alberta, Edmonton, Canada.

Professor Collip obtained from the parathyroid glands a hormone or extract which, when injected or given by the mouth, causes the amounts both of calcium and phosphate in the blood serum to rise. The parathyroids are four very small glands in the neck which lie near the thyroid gland or are embedded in it. His discovery was applied successfully to the cure of tetany, a somewhat rare disease usually found in children, and characterized by peculiar spasms.

A much wider utility for it is foreshadowed by the work done subsequently by Dr. Ogawa, in the surgical clinic of the Japanese medical academy of Keijo. As bone is so largely composed of calcium phosphate, a hormone which raises the amount of this substance in the blood might be expected to assist in bone formation. Rats with broken legs were found to produce twice as much new bone when fed with parathyroid glands as when not so fed.

Bone consists largely of calcium phosphate, and after a fracture fresh quantities of this substance must be taken from the blood for the formation of new bone. The slowness of the healing process seems to be largely due to the very small amounts of calcium and phosphorus in the blood.

The publication of the results in the case of human beings is awaited with the greatest interest, for there is reason to believe that the administration of parathyroid extract would not only hasten the healing of fractures in the young, but might render it possible in old age.—*Science Service.*

TEACHER VERSUS STUDENT DEMONSTRATIONS IN HIGH SCHOOL BIOLOGY.

By J. L. Cooprider,

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Introduction. In two other papers[1] I have given some data relative to the methods of presentation of laboratory exercises in high school biology. Since these papers were published another investigator[2] has published his results in the same field. Also, there have appeared studies of the same methods in the fields of physics[3] and chemistry.[4] To briefly summarize these studies it seems that the demonstration method of presentation is a little more effective than the individual method.

The Problem. The purpose of this study was to attempt to secure some objective data bearing upon the relative effectiveness of the teacher demonstration and the student demonstration of ordinary exercises in high school biology. The words "teacher demonstration" are used in this study to mean that the exercises were performed by the teacher. By "student demonstration" is meant that certain students of the class were selected to perform the exercise before the class instead of the instructor.

The Data. 1. *Intelligence Tests.* The first step in securing data to administer the Otis Self-Administrating Tests of Mental Ability: Higher Examination,[5] to each of four sections of high school general biology. These sections will be designated as Class A, Class B, Class C, and Class D throughout this report. It was found that the average score for Class A was 43.03 and that the average I.Q. was 104; for Class B, the average score was 48.05 and the average I.Q. was 107; for Class C, the average score was 44.81 and the average I.Q. was 105; for Class D, the average score was 43.76 with an average I.Q. of 105. These averages are about the same except for Class B which has a little higher average.

2. *Selection of the Exercises.* Eighteen exercises in high school biology were selected. These laboratory exercises were such as could be performed by the common demonstration method of instruction. Some of the exercises were far more difficult than others. Some were longer than others, thus consuming more

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[1]School Sci. & Math. 22:838-44: 1922. *Ibid* 23:526-30, 1923.

[2]Cunningham, H. A., Laboratory Methods in Natural Science Teaching, School Sci. & Math. 24:709-15; 848-51, 1924.

[3]Kiebler, E. W., and Woody, Clifford, The Individual Laboratory versus the Demonstration Method of Teaching Physics, J. of Educ. Research, 7:50-59, 1923.

[4]Wiley, W. H., An Experimental Study of Methods in Teaching High School Chemistry, J. of Educ. Psychology, 9:181-98, 1918.

[5]Published by the World Book Company.

time for their performance. Some of the exercises demanded little or no reasoning in coming to the conclusion. In some the student had to recall preceding exercises that had been performed in order to properly proceed with the exercise that was being performed. In one exercise (osmosis) the laboratory exercise was a mere discussion of osmosis and the laws governing it, the performance of the exercise having taken place before the class met.

3. *Selection of the Student Demonstrators.* Some of the students selected to do demonstration work had a low I.Q., and some had high I.Q.s, with others ranging in between. It was planned, in some cases at least, to give the longer and more difficult exercises to students whose ability ranked high and to give the simpler exercises to the poorer students.

4. *The Instructions for Working the Exercises.* These were in typewritten form. Each student, who was to perform the exercise, was given these very definite directions on the day before he was to demonstrate, thus giving him an opportunity to get acquainted with the steps in the exercise. None of the other students were given these instructions before the exercises were performed. If the student demonstrator had difficulty in understanding the instructions he usually informed the instructor, who cleared this difficulty before the class met. When the teacher did the demonstrating these same typewritten instructions were carried out "to the letter."

5. *Working the Exercises.* When the various classes assembled at their regular time, all apparatus and materials for working the exercises were on the demonstrating table. In most cases the student demonstrator looked over these materials before the class met, but in no case was he permitted to perform the exercise before the class met. In working the exercise the student demonstrator was not permitted to retain the typewritten instructions. The instructor also performed without the instructions before him. However, in either case the instructions were the same. In all cases the "object" or purpose of the exercise was stated before the exercise was begun. In some cases the instructions for working the exercises were given before the exercise was performed and in other cases the demonstrator told what he was doing as he proceeded. In either case, if the teacher demonstrator gave the instructions before or during the performance of the exercises, the student in the next class gave the same instructions before or during the performance. No dis-

cussion of the exercise was permitted until after the exercise had been written up by the student and handed in to the instructor.

6. *The Student's Record.* For his record each student was given a completion test form which had been mimeographed. The student filled in the blanks. This form consisted of four steps: Object, Procedure, Results, and Conclusion. For the "object" the student stated the purpose of the exercise. For the "procedure" he wrote up the things that were done in working the exercise. For the "results" he stated what happened as a result of the various manipulations which took place in the procedure. For the "conclusion" he stated or summarized the thing that he attempted to do or prove as stated in the object.

7. *Students' Opinions of the Methods.* After all of the exercises for this study had been completed the students' attention was called to the two methods of presentation and they were asked to write down whether or not they preferred the teacher demonstration or the student demonstration and to give as many reasons as they could for their answer. The students were told that either way they answered the question would not affect their grades in any way. These opinions are of value only in showing the students' attitude toward the methods.

Summary of the Findings of This Study. Detailed discussion of the data secured in this study and summarized in the appended tables will not be attempted here because of lack of space. Subject to correction or verification the following general observations may be noted for this study:

1. According to the scores obtained and according to the students' opinions, the teacher demonstration method gives better results than the student demonstration method. The advantages of the teacher demonstration method over the student demonstration method are not so great when considered from the percental scores made on both methods.

2. Where the teacher very closely supervises, students seem to obtain about as good results as the teacher. Close supervision may tend to overcome the differences in the scores of the two methods.

3. Returns seem to show that the better students can get about the same results as the teacher. In the case of the better students, less supervision seems unnecessary.

4. The poorer students do not seem to get returns that are satisfactory. First, the average score made in a class in which a poor student did the demonstration is very low. Second, there

is a much wider range of scores in the class where the poor student demonstrated than there is where the better student or the teacher demonstrated.

5. Exceptionally difficult exercises, where worked at all, should be worked by the teacher or by the very best students in the class. Many of the laboratory exercises found in laboratory manuals for high schools are by far too difficult for the best high school student. If students fail to understand an exercise because it is too difficult, then why should that exercise be included.

6. The length of the procedure of the exercise does not seem to greatly effect the returns of either method. The manipulation of apparatus is not so difficult with simple exercises that the students cannot obtain good results as demonstrators.

7. Experiments with considerable discussion by way of explanation of the exercise seem to give the best returns when done by the teacher. High school students do not seem able to read and understand such experiments so as to effectively present them before their class.

8. High school students do not seem to have learned to apply the knowledge they have gained and for this reason either of the two methods under consideration seem to fail completely. This application factor seems to be a most neglected part of science teaching, yet it is in the high school science course, perhaps more than any other high school subject, where greater opportunity is afforded for the application of knowledge gained in the course. In the "conclusion" (Table 4) students make their lowest scores, even though they do have all the data before them. The high school science teacher can render great service here, if he can develop in his students that faculty to reason to conclusion successfully.

9. Allowing the student to perform the exercise with the class as spectators certainly makes him responsible for his best work since he seems to feel that his failure would mean the failure of the class. This responsibility gives him a valuable training, so does his performance before the class. Allowing the student to perform the exercise before the class seems to give him a real reason for working as exercise thus giving him an added interest in the work. He must make a more thorough preparation of the exercise and give more attention to details where he is to demonstrate than where he is to perform the exercise individually.

10. This method of individual work seems more desirous than

that method of individual work in which each student performs the exercise for himself. In addition to the advantage enumerated above, we have the added advantages of saving of time and expense. Students who demonstrate, do not use any more time than is necessary to complete the exercise. They do not waste time as they are likely to where they may work with as much freedom as they like. This method will save the added trouble of equiping a laboratory for individual work. The money which is usually invested for individual equipment could be best invested in more and better equipment for demonstration purposes. To illustrate, in order to equip a class of 20 students with $50 microscopes our investment would be $2000, if we wish to do individual work. If we wish to do demonstration work, one $500 microscope would give far better results to the class and thus save $1500 to be used to purchase lantern slides, models, charts, books and many of the other equipment that could be used in demonstrations, which equipment is so often absent from the laboratory because that school purchased $50 microscopes. It seems that if a student can take a model, chart, or a test tube and explain an exercise to his class with about the same degree of efficiency as the teacher, this thing should be done. This seems to me the real duty of the teacher—that of directing the activities of the science class rather than performing for them.

TABLE 1.—Summary of the average percent scores made by each class in the *Object* of each exercise.

	Class A		Class B		Class C		Class D	
Exercise	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Stud't Dem.
1		66.67	80.95			50.00	64.47	
2	88.89			95.24	83.33			94.12
3		97.22	97.62			91.67	97.06	
4	88.89			100.00	100.00			94.12
5		100.00	100.00			100.00	100.00	
6	100.00			85.71	100.00			94.12
7		88.89	100.00			88.89	100.00	
8	94.44			85.71	88.89			100.00
9		88.89	100.00			100.00	100.00	
10	100.00			100.00	100.00			100.00
11		100.00	100.00			100.00	100.00	
12	83.33			54.14	72.22			76.47
13		100.00	90.48			100.00	88.24	
14	100.00			95.24	94.44			58.82
15		83.33	90.48			94.44	100.00	
16	88.89			57.14	88.89			58.82
17		77.78	85.71			83.33	88.24	
18	77.78			71.43	72.22			58.82
Aver.	91.36	89.19	93.92	83.07	88.89	89.81	93.12	81.45

TABLE 2.—Summary of the average percent scores made by each class in the *Procedure* of each exercise.

	Class A		Class B		Class C		Class D	
Exercise	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.
1		90.00	91.43			81.11	95.88	
2	81.56			76.00	79.44			73.82
3		87.17	71.71			88.39	67.00	
4	74.28			85.33	80.39			73.41
5		85.94	85.86			89.00	87.06	
6	92.22			85.67	79.22			78.41
7		93.89	89.52			87.17	86.41	
8	95.56			91.43	92.22			94.12
9		84.06	90.57			90.22	94.18	
10	98.00			99.43	98.00			97.12
11		75.39	89.86			82.94	88.71	
12	90.28			91.76	96.50			89.41
13		89.39	85.81			83.39	85.00	
14	92.17			96.00	81.71			92.24
15		87.22	90.48			79.39	79.71	
16	90.44			91.86	81.33			90.59
17		76.94	91.86			94.44	89.12	
18	95.00			71.48	86.11			86.47
Aver.	89.95	85.55	87.45	87.54	84.99	86.23	85.87	86.11

TABLE 3.—Summary of the average percent scores made by each class in the *Results* of each exercise.

	Class A		Class B		Class C		Class D	
Exercise	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.
1		61.11	82.86			77.78	77.65	
2	33.33			64.29	66.67			61.76
3		72.22	95.24			86.11	88.24	
4	47.22			66.67	83.33			58.82
5		45.83	42.86			47.22	47.01	
6	53.72			60.43	59.44			35.29
7		47.22	61.90			55.56	61.76	
8	77.78			95.24	94.44			100.00
9		58.33	88.10			75.00	76.47	
10	80.56			73.81	66.67			50.00
11		30.56	33.33			2.78	41.18	
12	57.39			36.19	57.56			33.29
13		64.89	52.48			55.61	45.06	
14	72.22			76.19	97.22			97.65
15		61.11	64.29			91.67	79.41	
16	66.67			66.67	50.00			20.59
17		88.89	100.00			88.89	100.00	
18	70.50			73.14	76.17			59.00
Aver.	62.15	58.90	69.01	68.07	72.35	64.51	68.53	57.31

TABLE 4.—Summary of the average percent scores made by each class in the *Conclusion* of each exercise.

	Class A		Class B		Class C		Class D	
Exercise	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.
1		22.22	57.14			22.22	29.41	
2	27.78			28.57	27.78			5.88
3		41.67	23.81			41.67	5.88	
4	16.67			23.81	16.67			29.41
5		61.11	71.43			38.89	5.88	
6	16.67			19.05	22.22			11.76
7		5.56	28.57			16.67	5.88	
8	27.78			23.81	38.89			35.29
9		16.67	42.86			33.33	17.65	
10	61.11			61.90	66.67			58.82
11		00.00	00.00			5.56	5.88	
12	00.00			00.00	00.00			00.00
13		5.56	00.00			00.00	00.00	
14	5.56			00.00	00.00			00.00
15		11.11	28.57			33.33	47.01	
16	5.56			15.29	00.00			00.00
17		15.56	54.29			24.44	48.24	
18	72.22			42.86	55.56			41.18
Aver.	25.93	19.94	34.08	23.81	25.31	24.01	17.42	20.26

Table 5.—Summary of the average percent scores made by each class on each exercise. The score is the average of the scores made in the object, procedure, results, and conclusion.

	Class A		Class B		Class C		Class D	
Exercise	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.	Teacher Dem.	Student Dem.
1		60.00	78.09			57.78	66.91	
2	57.20			66.04	64.33			58.92
3		74.60	72.13			76.98	64.56	
4	56.80			68.97	70.12			63.96
5		73.30	74.97			68.81	60.04	
6	65.70			62.74	65.23			54.91
7		59.00	70.02			62.09	63.54	
8	73.90			74.05	78.61			82.35
9		62.00	80.40			74.66	72.10	
10	84.90			83.76	82.82			76.49
11		51.50	55.82			47.84	58.94	
12	57.80			46.34	54.10			49.82
13		65.00	57.15			59.77	54.60	
14	67.50			66.86	68.37			61.89
15		60.70	68.46			74.73	76.57	
16	62.90			57.50	55.08			42.51
17		64.80	82.97			71.39	81.41	
18	78.90			64.50	72.55			61.59
Aver.	67.31	63.42	71.11	65.64	67.91	66.01	66.52	61.38

Table 6.—A distribution of the students according to their scores made on the Intelligence Test together with the average scores each made on nine exercises performed by teacher demonstration and on nine performed by student demonstration, together with the method preferred by each student.

Student	Rank intelligence test	Total average score made by–		Method preferred	Student	Rank intelligence test	Total average score made by–		Method preferred
		Tr. Dem.	St. Dem.				Tr. Dem.	St. Dem.	
14	1	89.03	93.29	Tr. Dem.	120	38.5	66.66	63.12	Tr. Dem.
23	2	69.09	65.52	Tr. Dem.	320	38.5	69.11	72.38	Tr. Dem.
33	3	83.84	79.62	Tr. Dem.	13	40	72.46	61.00	Tr. Dem.
22	4	82.60	77.93	Tr. Dem.	112	41	61.38	59.89	Tr. Dem.
44	5	70.28	71.96	Tr. Dem.	11	42.5	58.13	59.08	Tr. Dem.
28	6	71.63	65.49	Tr. Dem.	38	42.5	68.22	70.02	Tr. Dem.
411	7	75.16	63.04	St. Dem.	48	44	66.32	63.12	St. Dem.
215	8	66.41	66.93	Tr. Dem.	19	46	65.12	60.11	Tr. Dem.
214	9.5	76.74	59.04	Tr. Dem.	27	46	75.78	74.81	Tr. Dem.
219	9.5	83.04	66.57	Tr. Dem.	39	46	63.50	60.11	Tr. Dem.
111	11.5	62.38	70.16	Tr. Dem.	218	48.5	65.99	56.08	Tr. Dem.
115	11.5	73.23	70.76	St. Dem.	312	48.5	69.01	62.22	Tr. Dem.
35	13	78.43	70.51	None	37	50.5	50.42	51.78	Tr. Dem.
212	14.5	65.04	74.07	St. Dem.	317	50.5	75.40	65.91	Tr. Dem.
47	14.5	72.88	80.04	Tr. Dem.	113	53.5	69.55	67.50	None
220	16.5	70.82	71.76	St. Dem.	32	53.5	72.41	72.71	Tr. Dem.
319	16.5	65.38	68.36	Tr. Dem.	310	53.5	53.01	64.32	Tr. Dem.
216	18	69.60	69.77	St. Dem.	46	53.5	60.21	60.43	None
315	19	65.29	57.12	St. Dem.	221	56.5	72.20	58.62	Tr. Dem.
24	20.5	60.33	58.19	St. Dem.	26	56.5	73.37	62.02	Tr. Dem.
316	20.5	72.59	68.93	Tr. Dem.	210	58	63.60	65.68	St. Dem.
413	22	73.66	67.69	Tr. Dem.	217	59.5	71.19	62.12	Tr. Dem.
21	24	80.58	71.73	Tr. Dem.	31	59.5	73.73	67.96	Tr. Dem.
311	24	65.84	64.91	Tr. Dem.	45	61	63.22	62.08	Tr. Dem.
417	24	68.37	52.08	Tr. Dem.	211	62	81.09	77.12	Tr. Dem.
117	26	64.60	58.77	Tr. Dem.	114	63	73.43	68.99	Tr. Dem.
16	27	63.61	60.89	Tr. Dem.	12	64.5	59.47	55.59	St. Dem.
42	28	67.79	70.41	Tr. Dem.	18	64.5	68.97	64.89	Tr. Dem.
418	29	70.36	70.04	Tr. Dem.	412	66	77.52	52.62	Tr. Dem.
15	30.5	74.69	59.90	Tr. Dem.	25	67	63.73	51.10	Tr. Dem.
410	30.5	63.82	58.60	Tr. Dem.	213	69.5	58.49	54.62	Tr. Dem.
36	32.5	64.74	63.62	Tr. Dem.	318	69.5	57.16	50.56	St. Dem.
313	32.5	74.32	73.08	Tr. Dem.	43	69.5	48.36	44.89	Tr. Dem.
415	35	64.80	72.28	None	414	69.5	58.78	38.90	Tr. Dem.
29	35	72.07	69.32	Tr. Dem.	119	72	47.81	49.19	Tr. Dem.
49	35	60.56	59.18	Tr. Dem.	118	73	74.73	61.40	St. Dem.
17	37	66.36	57.06	Tr. Dem.	416	74	68.74	56.17	Tr. Dem.
Average above median		70.81	67.53		Average above median		65.90	60.79	

Table 7.—Summary of Table 6 in order to compare the data above and below the median score as based upon the intelligence test score.

Number above the median who give preference to teacher demonstration	28
Number above the median who give preference to student demonstration	7
Number below the median who give preference to teacher demonstration	30
Number below the median who give preference to student demonstration	5
Number above median who make better scores with teacher demonstration	26
Number above median who make better scores with student demonstration	11
Number below median who make better scores with teacher demonstration	28
Number below median who make better scores with student demonstration	9

Number above median who make better scores with student demonstration but who prefer teacher demonstrations	7
Number above median who make better scores with teacher demonstrations and who prefer teacher demonstrations	20
Number above median who make better scores with student demonstrations and who prefer student demonstrations	3
Number above median who make better scores with teacher demonstrations but who prefer student demonstrations	5
Number below median who make better scores with student demonstrations but who prefer teacher demonstrations	7
Number below median who make better scores with student demonstrations and who prefer student demonstrations	1
Number below median who make better scores with teacher demonstrations and who prefer teacher demonstrations	23
Number below median who make better scores with teacher demonstrations but who prefer student demonstrations	4

CHANGES IN OCEAN DEPTHS PUZZLE NAVY OFFICIALS.

Vessels of the U. S. Navy will soon be employed in an effort to locate a reported shoal extending southeast from Cape Hatteras, and reported recently by a merchant vessel, the "West Selene": says Capt. W. S. Crosley, chief hydrographer of the navy. This boat was forced towards shore in foggy weather and made sounding to avoid getting too close to the beach, but they found depths of only 300 feet where the navy department's charts showed three times as much.

Apparently the report is correct, said Capt. Crosley, but alterations are not to be made on the charts until the changes have been officially verified. For this reason soundings by naval vessels in this region will soon be made. If the shoal is found, it will be most remarkable, he said, because it is certain that it was not there at the time the soundings on which the charts are based were made. The hydrographic office has no record of any such changes in the ocean bottom on any part of the Atlantic Coast.

Changes have been found in other parts of the world, however, the hydrographer continued, especially around Japan. They followed the great earthquake of 1923, and the Japanese navy is now engaged in an extensive survey to determine the extent of these changes. Similar changes in the Bay of Biscay, where, at a supposed depth of 24,000 feet, a depth of only 120 feet was reported, have not been verified. Soundings over this region have been made by a French naval vessel, the "Loriet," and they found nothing abnormal.

Capt. Crosley suggests that such reports might arise when a lead is used for soundings, as the line may become fouled before the weight reaches the bottom. The sonic depth finder is not subject to this source of error, and American naval vessels are now being regularly equipped with them. During the recent Pacific cruise of the fleet an extensive series of soundings was made, which the hydrographic office is now engaged in tabulating. This is expected to be especially valuable, as the only soundings now available of much of this area are those made when cables were laid to Alaska and to Guam.—*Science Service.*

THE ROLE OF HABIT IN REASONING.[1]

By Linus W. Kline, Ph.D. and Phoebe King Anderson, B.S.
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Introduction:

Comparatively little attention has been given as yet to an experimental study of reasoning, due in part to the difficulty in securing material susceptible of complete experimental control and further to a certain loftiness inherited from its philosophical treatment which held it as a mental entity quite apart from the rest of our mental powers.

Even so good a geneticist of mind as Lloyd Morgan holds that only those beings reason who are capable of "focusing the therefore"; and he implies that reasoning is a conscious attempt to justify our conclusions. For centuries no one pretended to think of reasoning outside of the syllogistic straight-jacket.

James saw reasoning in a functional aspect and defined it as "the substitution of parts and their implications or consequences for wholes." Stratton, Woodworth and others point out that both logic and psychology have separate interests in reasoning. Binet saw reasoning in terms of associationism. He says "there are three images involved in reasoning. The first calls forth the second by resemblance (similarity). The second suggests the third by contiguity and this is all that there is in reasoning." Thorndike says in a recent paper: "The older psychology perpetuated in current educational doctrines and practices regarded reasoning as a force largely independent of associative habits which worked back to correct or oppose them. Our present psychology finds that the mind is ruled by habit throughout.......... It defines reasoning as the organization and co-operation of habit and association working together, in almost every act of thought." Lindley in his study of puzzles saw the effect of habit on the solving of puzzle-problems.

Titchener's extensive and critical summary of experimental work done on "Thought Processes" during the first decade of this century revealed three things pertinent to the present paper: (1) that attitude, purpose, habit, associations and various sorts of imagery are essential factors in our thinking mechanism; (2) that much of the material used in the investigations was not susceptible to wide variations under adequate control and checks; (3) that oftentimes both the material and the conditions produced introspective results that defied verification.

[1]Contributions from Skidmore Psychological Laboratory.

Kline in "An Experimental Study for Classes in Reasoning, etc.," used problems consisting of two series of questions asking for dates prepared in a special order according to day, date and time interval. An example of a question in Series A of his material is: "If Wednesday is Jan. 28th, what will be the date of next Monday?" The required date always fell either in the preceding or the following month. In Series B, the date sought always fell in the same month. Both Series A and B were similar in that the date asked for was alternately past and present, and that the interval between days varied uniformly and was repeated in regular order, such as 5, 4, 6, etc.

These questions were asked orally and the time required by the respondent to solve them was taken. Results from several uniform recurring problems were obtained; it was possible to compare rate and manner of responses to questions of future and past dates, of odd and even dates, of time intervals composed of an even or odd number of days, etc., etc. Such problems made it possible to call for introspective reports from constantly recurring conditions and thereby to observe the effect of a growing habit on problem solving. This paper suggested in part the plans and material of the present study.

PLAN, MATERIAL AND PROCEDURE:

A. The plan of the experiment is as follows: Four subjects are used throughout the study. There are four sets of questions, two being problems on a seven-day week and the other two, problems on an eight-day week as explained later. Two subjects respond first to the problems on the seven-day week and then the eight-day week while the other two subjects respond first to the eight-day week and then to the seven-day week. The time of each response is taken and a verbal report is made by the subject as to how the problem was solved.

B. Material: The material includes the Johns Hopkins chronoscope and 400 questions formulated as follows: The first two hundred concern a seven-day week. In the first 100 questions are given two dates and one day, to find the other day, e.g.: "If Thursday is the twelfth, what day is the eighteenth?" The questions involve a constant order of days so that each day of the week is involved the same number of times. The order of days is as follows: Thursday given in first question, Wednesday given in second question, Sunday given in third question, etc., Saturday, Tuesday, Friday, Monday. Also the time intervals between the days occur in a fixed order. The questions alternate,

one referring to the future and the next to the past, and are referred to as plus and minus, e.g.: "If Wednesday is the 10th, what day *is* the 18th?" would be followed by "If Sunday is the 16th, what day *was* the 12th?" The order of interval is +6, −8, +4, −5, i.e., the first question would be an interval of six days ahead, the next eight days back, the next four days ahead, etc.

In the second hundred are given two days and one date to find the other date, e.g.: "If the 23rd is Monday, what is the date of next Saturday?" Here, the order of days differs and is as follows: Saturday, Monday, Thursday, Tuesday, Friday, Sunday and Wednesday. The time interval includes the same numbers but with the opposite signs to those in Series I and in a different order: +8, −6, +5, −4. The subjects never seemed aware of this particular order of days and intervals.

The second 200 questions concern an eight-day week. Here a new day termed Starday is inserted between Sunday and Monday, thereby giving the week eight days. In the first 100 of this series two dates and one day are given to find the other day, e.g.: "If Starday is the 12th, what day is the 17th?" The order of days is: Starday, Thursday, Wednesday, Sunday, Saturday, Tuesday, Friday, Monday. Here it is necessary to have different intervals of time, due to the fact that with eight days and four different intervals, every eighth trial, the day would fall on the same interval as before. Therefore, five intervals are used: +5, −4, +9, −6, −7, making two minus questions fall together.

In the second 100 of this eight day series are given two days and one date to find the other date, i.e.: "If the 17th is Friday, what was the date of last Starday?" The order of days is: Tuesday, Friday, Monday, Starday, Thursday, Wednesday, Sunday, Saturday. The order of time interval is the same as in the first 100 of this group except that the sign is reversed, reading: −5, +4, −9, +6, +7.

C. Procedure: As explained in the plan, two subjects started with the questions on the seven-day week and proceeded to the eight-day while the other two started with the eight-day and proceeded to the seven-day week. The subject sat at one end of the table on which the chronoscope was placed. The question was read and on the last word of the question, the operator started the chronoscope. As soon as subject solved the problem, she responded orally and thereby stopped the chronoscope. The time was recorded in sigma of seconds, also any peculiar actions on the part of the subject

and the methods of reasoning used. Twenty-five questions were asked at one period and periods were held twice a week. When errors were made, that question was given again at a later time, usually unobserved by the subject, until all were answered correctly.

D. *Results:* The results are given in the following order:

1. A sample of the tabular form in which raw results are recorded.

2. A table for (a) the average of the two subjects responding to the seven-day week followed by the eight-day week; (b) the average of the two subjects responding to the eight-day week followed by the seven-day week.

3. A table showing the relation of Plus questions to Minus questions for all four subjects.

4. A graph showing day to day improvement for each subject, based upon the average time for the 25 trials given at each meeting. The time average is plotted on the abscissa and the number of the period on the ordinate.

5. A discussion of the results showing the principles and methods involved in reasoning and the relation of the nature of the questions to the results. Since solving the problem always required a second or more, the time was converted from sigma to seconds and tenths.

Sample of Method of Recording.

Table I.—Individual Record Of Subject Pt.

Series I. 7-day week: Two dates and one day to find the other day. Order of days given in questions: Thursday, Wednesday, Sunday, Saturday, Tuesday, Friday, Monday. Order of Time Interval: 6, −8, 4, −5.

Correct Trials	No. of Questions	Intervals	Time
1	1	+6	2.3
2	3	+4	2.7
3	5	+6	1.6
4	6	−8	1.7
5	7	+4	2.4
6	9	+6	1.7
7	10	−8	4.0
8	11	+4	1.9
9	12	−5	4.1
10	13	+6	1.2
11	14	−8	2.7
12	15	+4	1.7
13	16	−5	5.3
14	17	+6	1.3

This table to be read as follows: The first correct trial is in answer to Question I, the interval of that question being

plus 6 and the time required, 2.3 seconds. The second correct trial is in answer to Question III (meaning the subject failed on Question II) the interval being plus 4 and the time required, 2.7 seconds. The 14th correct trial is in answer to Question XVII, etc.

TABLE II.—COMPARISON OF TRIALS AS TO DIRECTION, PLUS OR MINUS.
A. Showing Results of Subjects Pl and K, Responses to 7-day Week followed by 8-day Week.

Interval	Series I 7-day Week		Series II 7-day Week		Series I 8-day Week		Series II 8-day Week	
	*+	−	+	−	+	−	+	−
4	4.45			6.7		9.4	6.	
5		5.2	5.7		8.2			6.3
6	4.9			4.77		8.3	7.	
7						7.	4.5	
8		4.7	3.4					
9					6.6			4.6
Average	4.67	4.8	4.2	5.7	7.4	8.2	5.8	5.45
Average of + and −	4.7		4.8		7.8		5.6	
Average of I and II	4.75				6.7			

Difference in Seconds between 7-day and 8-day Trials........1.95 Seconds

*The sign + represents FUTURE. The sign − represents PAST.

TABLE II. COMPARISON OF TRIALS AS TO DIRECTION, PLUS OR MINUS
B. Showing Results of Subjects Pt and J, Responses to 8-day Week followed by 7-day Week.

Interval	Series I 8-day Week		Series II 8-day Week		Series I 7-day Week		Series II 7-day Week	
	+	−	+	−	+	−	+	−
4		4.	3.8		2.3			3.6
5	3.7			4.7		2.7	2.9	
6		4.8	4.5		1.75			2.5
7		3.3	3.4					
8						2.3	2.1	
9	3.3			3.65				
Average	3.5	4.	3.9	4.1	2.	2.5	2.4	3.5
Average of + and −	3.75		4.		2.25		2.95	
Average of I and II	3.87				2.6			

Difference in Seconds between 8-day and 7-day Trials........1.27 Seconds

TABLE III. SHOWING THE RELATION OF PLUS QUESTIONS TO MINUS QUESTIONS.

Interval:	4 da.		5 da.		6 da.		7 da.		8 da.		9 da.	
Subj.	+	−	+	−	+	−	+	−	+	−	+	−
Pl.	6.2	9.5	7.8	7.2	6.2	7.2	4.1	7.0	4.1	4.6	8.9	3.4
K.	4.2	6.6	3.6	4.2	5.7	5.8	4.9	7.0	2.7	4.8	4.4	5.9
Pt.	2.8	3.3	3.0	3.4	2.7	2.8	1.9	2.3	2.0	1.9	2.4	3.7
J.	3.3	4.4	3.6	4.0	4.7	4.5	5.0	4.3	2.2	2.8	4.2	3.6
Av.	4.1	5.7	4.5	4.7	4.5	5.0	3.9	5.1	2.7	3.5	4.9	4.1
Total Av.	4.9		4.6		4.7		4.5		3.5		4.5	

PRINCIPLES AND METHODS USED AND THEIR RELATION TO THE NATURE OF THE QUESTION.

The general methods may be summarized briefly as follows:

The first consisted chiefly of counting on the fingers or with the lips; lack of bodily control and restlessness were apparent. During this stage, the subjects became used to the chronoscope and to the nature of the problem, and then gradually passed to a more deliberative stage in which plans and methods were devised for handling the calculations with more ease, accuracy and confidence, such as adding or subtracting a certain number for a certain interval. This stage developed slowly but with practice the subjects became more efficient and confident in their responses.

The final stage is marked by more or less automatic responses. The relation of days could be seen without counting and habit seemed to be replacing conscious effort and reasoning. The bodily attitude was relaxed, and the responses confidently made.

Specific Methods:

A. For two dates and one day, to find the other day: The method of procedure for such a question was the same with three subjects and varied with the fourth. The first method consisted of obtaining the difference between the two dates given and then adding or subtracting that many days to the one day given, e. g.:

If Wednesday is the 14th, what day is the 20th? The procedure is: (1) 20 minus 14 = 6. (2) The Wednesday plus six days equals Tuesday. The methods of the 2nd step varied according to the interval found, as explained later.

The 2nd method consisted of adding a week if the question was plus or subtracting a week if minus and counting from that day and date to the required one, e. g.: If Wednesday is the 14th, what day is the 20th? Procedure: Wednesday the 14th + one week = Wednesday the 21st. Then counting to the 20th would be one day less or Tuesday. In the 8-day week, the procedure was the same except that 8 was added instead of 7.

B. For two days and one date to find the other date: As in A, three subjects acted alike, the fourth differently. The first method consisted in obtaining the difference between the two days given then adding or subtracting the interval to the date given, e. g.:

If the 14th is Wednesday, what is the date next Tuesday? Procedure: (1) From Wednesday to Tuesday is figured to be six days. (2) The question being plus, 6 is added to 14 = 20.

Methods of step (1) varied according to the days given. The 2nd method consisted of adding or subtracting a week to

or from the date given and then figuring from that day and date the required date, e. g.: If the 14th is Wednesday, what is the date of next Tuesday? Procedure: Wednesday the 14th and one week equals Wednesday the 21st. (2) Tuesday is the day before therefore one less = the 20th. Or, if the question were minus, e. g.: If Wednesday is the 14th, what date was last Tuesday, she proceeds as follows: Her thought being: What number with 7 will give 14? The answer being seven, she realizes that the last Wednesday was the 7th and that Tuesday must have been the 6th. In the 8-day week, the method was the same except that 8 was added or subtracted instead of 7.

Methods of Reasoning for Intervals:

A. ± 4 days: With a seven-day week, the method used with $+4$ consisted chiefly in counting ahead four on the fingers or lips and with -4 back. In later trials for -4, the subject took the difference between 4 and $7=3$, and counted 3 days ahead which is easier than 4 days back.

In the 8-day week, -4 was computed in the same manner at first, counting ahead or back 4, until the subjects realized that ahead 4 was the same interval as back 4 in the 8-day week and after that, they counted *forward* in preference.

With Subject Pl., the method varied slightly for -4. She would subtract 7 or 8 from the given day or date, then count ahead 3 days in a 7-day week or 4 in an 8-day week and often name each intervening day with its respective date as she counted.

B. ± 5 days: In the first stage, a -5 interval was attempted by counting each day but this was difficult and long and the following plan was soon adopted: 5 days equals 2 days less than a 7-day week, therefore if the question is $+5$, subtract 2 days; if the question is -5, add 2 days to the given day. In the 8-day week, 5 days is 3 days less than a week, so 3 days were added or subtracted to the given day or date.

Subject Pl. varied here as usual, adding or subtracting the week, then counting ahead or back 2 days in the 7-day week or 3 days in the 8-day week, to the required day or date.

C. ± 6 days: In the 7-day week, ± 6 was one day less than a week and therefore comparatively easy. $+6$ meant one day before the given day and -6 meant one day after the given day.

With Subj. Pl., she as usual added the week of 7 days and in this case counted ahead one day if the question was minus and back one day if it were plus.

±6 in the 8-day week consisted of 2 days less than a week and was somewhat more difficult. The subject here counted ahead 2 days from the given day if the question were minus and back 2 days if it were plus, i. e.: If Saturday is the 12th, what day is the 18th? Procedure: $18-12=6$; the direction is ahead and 2 days less than a week; therefore, 2 days back from Saturday is Thursday. With Subj. Pl. the procedure was as follows: Saturday the 12th + a week equals Saturday the 20th; therefore Friday was the 19th and Thursday the 18th.

D. ±7 days: This interval occurred only in the 8-day week and was one day less than the week, therefore quite easy. The subjects counted one day back if the question was ahead and one day ahead if back.

Subj. Pl. as usual added or subtracted the week, then counted back or ahead one day.

E. ±8 days: This interval was used only in the 7-day week and was one day more than the week and therefore not difficult. The method consisted of thinking one day ahead if plus or one day back if minus, thereby having one day more than a week in either direction. Subj. Pl. added the week then thought ahead one day or subtracted a week and thought back one.

F. ±9 days: This interval was used only in the 8-day week and being one more than the week was calculated in the same manner as ±8 in the 7-day week.

Factors Affecting Difficulties in Reasoning:

As is shown in Table III on page 10, with the exception of the interval 9, the minus questions are more difficult than the plus. This is no doubt due to the fact that it is easier and more habitual for us to count forward than backward and to add than to subtract. The −9 questions were in the last of the 8-day series and solving questions with this interval so reading might be explained on the ground that the subject was more at ease with the 8-day week by then than in the first series containing +9.

It is also noted that time intervals near the span of a week are less difficult than those not near the week. It was found that 6, 7, 8, 9 are all easier than 4 and 5 which are two or three days less than a week, while 6, 7, 8 and 9 are all only one or two days from the week.

Again, it is noted from individual records that in the majority of cases the questions of Series I, with two dates and one day, are easier than those of Series II, with two days and one date. This is due to the fact that it is easier to subtract the two dates given than the two days, i. e., it is easier to find the difference in days between 16 and 20 than between Tuesday and Saturday, because we are accustomed to subtracting numbers but not days. Where a number is concerned, the operation is easier than with days only.

SPECIAL DIFFICULTIES OF THE SUBJECTS:

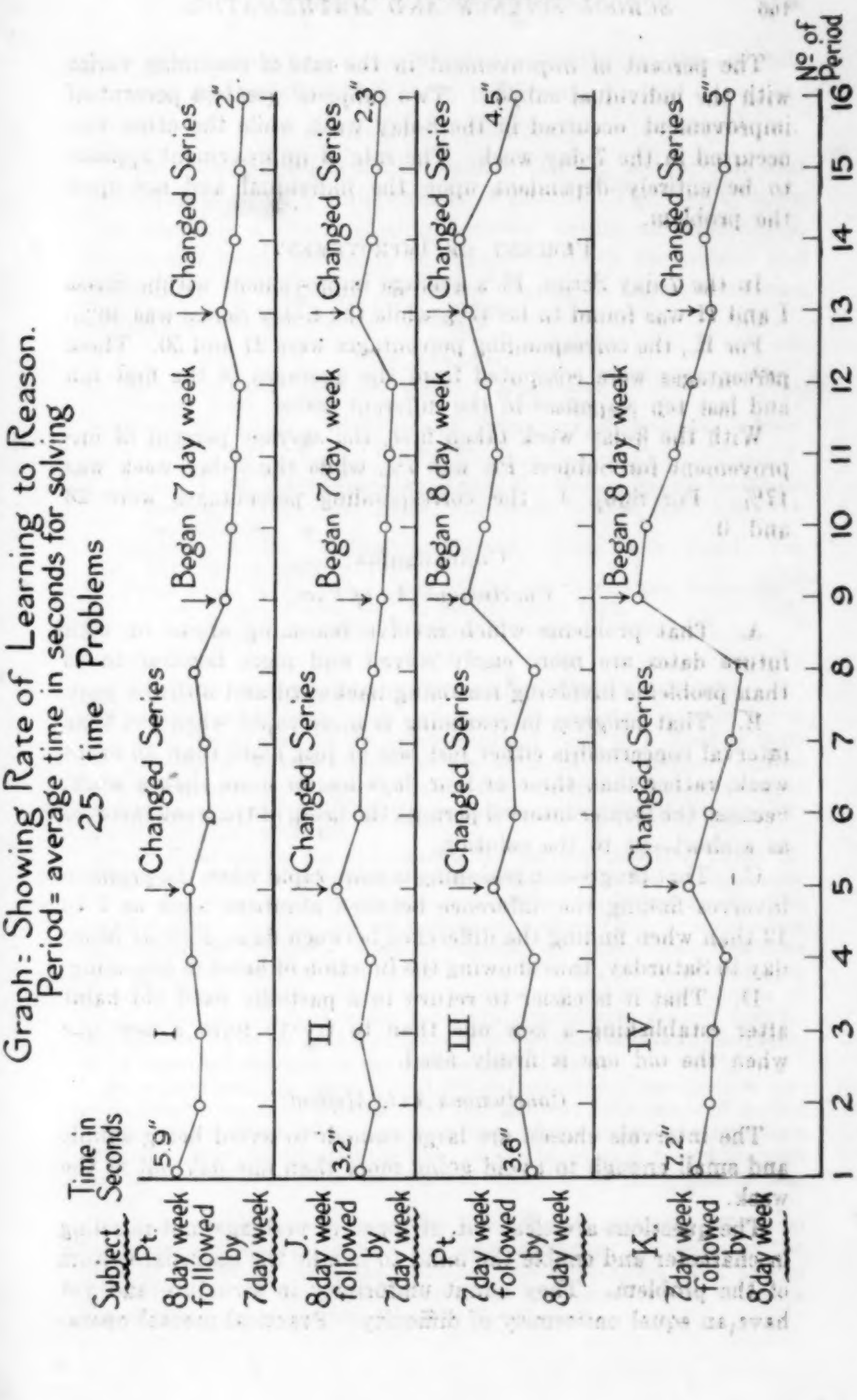
The subjects were at first bothered by the noise of the chronoscope and the slightest outside distraction, however, after the first few meetings, they became used to the machine and the manner of responding became increasingly automatic.

The subjects were slower some days than others, especially if at all worried about outside matters or fatigued. At times they would have streaks of rapid responses, especially those subjects meeting the first hour in the morning.

Arithmetical errors were few after the problem became familiar to the subject and mistakes in reasoning lessened as they proceeded. In the main, errors were due to forgetting the problem, to confusion in counting backward, confusion in direction or confusion between plans for solving which closely resembled each other, as $+7$ and -9.

When the 7-day week was followed by the 8-day week, both subjects required on the average, 1.7 seconds longer to solve the 8-day week problems. This same result was obtained by Subject J, who used the 8-day week first. Subject Pt., who was paired with J, required .95 seconds longer to solve the 8-day week problems.

Those subjects going from the 8-day week to the 7-day week found the change relatively easy while those going from the 7 to the 8-day found the latter extremely hard. (See 9th Period in Graph.) It appears easier, then, to return to a partially fixed old habit after establishing a new than to try to form a new one when an old related one is firmly fixed. The graphs I and II of the two subjects responding first to the 8-day week showed gradual decline throughout, with slight rise at the beginning of a new series, (that is, every 5th period.) The graphs of the other two subjects show sharp rises at the beginning of the 8-day week and a lesser rise at the beginning of each series. The arrows in the graph direct attention to these features of the learning.


Graph: Showing Rate of Learning to Reason.
Period = average time in seconds for solving
25 time Problems
Subject
Pt.
8 day week followed by 7 day week
J.
8 day week followed by 7 day week
Pt.
7 day week followed by 8 day week
K.
7 day week followed by 8 day week
Time in Seconds
5.9"
3.2"
3.6"
7.2"
I
II
III
IV
Changed Series
Began 7 day week
Began 8 day week
2"
2.3"
4.5"
5"
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
No. of Period

The percent of improvement in the rate of reasoning varies with the individual subject. Two subjects' greatest percent of improvement occurred in the 8-day week while the other two occurred in the 7-day week. The rate of improvement appears to be entirely dependent upon the individual and not upon the problem.

PERCENT OF IMPROVEMENT:

In the 7-day Series, Pl.'s average improvement within Series I and II was found to be 37% while the 8-day Series was 36%.

For K., the corresponding percentages were 21 and 50. These percentages were computed from the averages of the first ten and last ten responses in the different series.

With the 8-day week taken first, the average percent of improvement for Subject Pt. was 7% while the 7-day week was 17%. For Subj. J., the corresponding percentages were 28 and 0.

CONCLUSIONS:

Conclusions As to Fact:

A. That problems which involve reasoning ahead or with future dates are more easily solved and more familiar to us than problems involving reasoning backward and into the past.

B. That progress in reasoning is more rapid when the time interval concerned is either just less or just more than an exact week, rather than three or four days less or more than a week, because the former interval permits the using of the week interval as a short cut to the solution.

C. That progress in reasoning is more rapid when the problem involves finding the difference between numbers, such as 7 to 12 than when finding the difference between days, such as Monday to Saturday, thus showing the function of habit in reasoning.

D. That it is easier to return to a partially fixed old habit after establishing a new one than to try to form a new one when the old one is firmly fixed.

Conclusions As to Method:

The intervals chosen are large enough to avoid being simple and small enough to avoid going more than one day out of the week.

The questions are clear cut, stripped of verbiage, not puzzling in character and enable the mind to handle the essential factors of the problem. They admit uniformity in structure and yet have an equal uniformity of difficulty. Practical mental opera-

tions about time and dates which are familiar to the subjects are used in the solving of these problems.

Conclusions As to Theory:

This investigation tends to weaken the old assumption that reasoning is entirely independent of habits. The results show that there is a close relation between habits and reasoning, the former being necessary in furnishing both the means and the content in reasoning, the latter ceasing to function as soon as appropriate habits are formed.

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HIGH BLOOD PRESSURE REDUCED BY LIGHT.

The problem of high blood pressure has had light thrown on it in a most literal way by the experiments of Prof. C. I. Reed of Baylor University. If the results he has obtained with animals can be extended to apply to human beings, it may mean that this great curse of middle age will be lifted by nothing more difficult than scientifically applied sunbaths.

Prof. Reed began his experiments by shining powerful lights directly into the eyes of anesthetized animals, so that the beams would fall on the thick network of minute blood vessels lining them. The arterial blood pressure fell off rapidly in a short time, in some cases as much as 80 per cent. Then he repeated his experiment, this time throwing the light on the lining of the mouth, which is also rich in small blood vessels. Here also he obtained marked diminution of blood pressure. In both cases auxiliary experiments showed that no explanation could be found in theories of nervous effects of the light, or of chemical changes in the tissues caused by it.

As a final test, Dr. Reed placed his animals under anesthetics, severed arteries in their throats, and into the cut ends inserted quartz tubes, so that these tubes became a part of the animals' circulatory systems. Then he directed the light on the blood as it flowed through the tubes, and once more the marked lowering of the pressure was noted.

In none of the experiments, Dr. Reed stated, could the effects be traced to any special part of the light spectrum. In some of the tests he filtered out both the infra-red and ultra-violet rays, and in others he used all the radiation from his arc lamps; but in all cases his results were the same.—*Science Service.*

LIQUID AIR.

By Bernard Jaffe, M. A.
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Men have attempted to trace the history of mankind from the point of view of climate. They point out, for example, that very little of the progress of the world came from the tropics. Man cannot develop the higher qualities under the heat of the torrid sun nor in the frozen wastes of the polar regions. Other historians have tried to rearrange the history of civilization to show how the thermometer controlled critical world movements. The great invasion of the Tartars was caused to a great extent by climatic conditions. Napoleon was thwarted in his attempt to conquer the world not so much by man as by temperature. No one will deny that temperature shapes our thoughts, activities, our very lives.

Temperature interests the scientist for other reasons. Temperature fascinates him. When the scientist investigates a subject he does not rest content until he has delved into its very heart. He was not satisfied with the heat of a Bunsen flame nor even with that of the blast furnace. He invented the oxy-hydrogen torch and then the electric furnace which gave him a temperature of almost 4000°C—a temperature approaching that of the sun. The temperature of ice was not low enough nor did a freezing mixture of −30°C satisfy him. From theoretical calculations he found that an Absolute temperature of −273°C could be approached and he did not let up until he had come within about 3° of it when, 16 years ago, Dr. K. Onnes of Leiden liquified helium at a temperature of −268.5°C.

Just now we are interested primarily with exceedingly low temperatures. Let us trace the history of this subject. It has been known for more than a hundred years that gases like chlorine and sulphur dioxide could be changed into liquids by cooling them sufficiently to slow down the movement of the molecules which compose them. According to the kinetic theory of gases the same result could be obtained by compressing the gas under intense pressures and, in fact, both chlorine and sulphur dioxide were liquified at room temperature by compression alone.

By lowering the temperature and increasing the pressure then, all gases ought to yield to liquification. Most of the common gases yielded, others like oxygen, hydrogen, nitrogen,

and helium refused to respond to this treatment. Perhaps they had not been subjected to pressures high enough. So the investigators brought into play hitherto unobtainable pressures. For example, Natterer in 1855 subjected gases to a pressure of 2790 atmospheres or more than 20 tons per square inch. Yet they refused to condense. The experimenters were puzzled until 1869 when Andrews discovered the law that every gas has a temperature (the critical temperature) above which no amount of pressure would produce liquefaction. Now Cl (c. t. 141°C), SO_2(154°), CO_2(31.5°), and H_2S(100°) had easily been liquified because their critical temperatures were above normal temperature. On the other hand, Oxygen (−183°C), Hydrogen (−242°), Nitrogen (−146°), and Helium which refused to be liquified all had critical temperatures which were extremely low.

The solution, then, lay in obtaining very low temperatures. The pioneers in this field were Claude, Pictet, and Caillettet in France, Linde in Germany, Dewar and Hampson in England, and Tripler in our own country. They all obtained low temperatures by processes based on a simple physical phenomenon. Any liquid on evaporating absorbs heat. When water evaporates from your body the body is cooled. The more rapid the evaporation the colder the object becomes. Ether evaporating quickly from your hand lowers its temperature until it becomes uncomfortably cold. The artificial preparation of ice depends upon the cooling effect produced by the rapid evaporation of liquid ammonia or liquid sulphur dioxide. For the same reason the sudden expansion of a gas in a vacuum cools that gas. A very successful apparatus for liquifying a gas is that devised by Hampson. The gas is passed through pipes at a pressure of about 150 atmospheres. On expanding suddenly the temperature of the gas is lowered. The process is continuous and the temperature becomes lower and lower until the gas liquifies. All of the known gases have yielded by this process, but not until the extremely low temperature of −269°C had been reached did helium deliver its ghost and turn liquid.

When oxygen and nitrogen had both been liquified, oxygen at about −182°C and nitrogen at −195°C the next step was to liquify the air which is a mixture of approximately 78% nitrogen, 21% oxygen, 1% argon and the other noble gases, and small amounts of impurities like carbon dioxide. In "Gulliver's Travels" he visits a famous academy and reports how some scientists were condensing air and letting the fluid particles

percolate. Thus Swift in this sarcastic story selected the liquifaction of air as a dream never to be realized.

Yet only forty years ago Wroblewski and Olszewski, two Poles, succeeded in liquifying a small volume of air, and a few years later the Englishman Dewar working in the laboratory where Faraday made his pioneer experiments with chlorine, prepared liquid air in appreciable quantities. Still until quite recently it remained hardly more than a laboratory curiosity. To-day it is made by the thousands of gallons and constitutes a commercial source of pure oxygen and nitrogen. In spite of its manufacture on a large scale few people have heard of it, fewer have seen it, and very few indeed have handled it. Why? Chiefly because of the difficulty of preserving it, and the risk involved in handling it due to its fearfully low temperature.

The amazingly low temperature of liquid air makes it a source of danger and one must handle it with extreme care. Yet, with caution, we can let a stream of this substance fall on the back of one's hand without injury. Owing to the very high temperature of the skin in comparison with liquid air a layer of evaporated water is formed between the liquid air and the skin which prevents a contact, which, if it did occur would destroy the tissues after the fashion of a violent burn. We can even plunge a finger into liquid air but only for a moment. A second too long and the finger would change to a motionless, yellowish, brittle object very easily shattered with the blow of a hammer.

Let us study its physical and chemical properties, the effect of its extreme cold, and its uses in the order named.

Physical Properties.

1. It is a limpid liquid closely resembling water except that it is slightly bluish in color due to the blueness of thick layers of oxygen. Perhaps this accounts for the blue of the sky. This may or may not be the true explanation and much verbal fireworks have been exploded over this question.

2. In a naked flask it boils off rapidly. The smoke one notices is not that of liquid air but is due to the instantaneous condensation of such impurities in the air as moisture and carbon dioxide. To preserve it, therefore, for any length of time we must insulate it from surrounding bodies which are relatively at a temperature of a hot furnace, liquid air acting just as water does on a hot stove. Hence liquid air is preserved and transported in containers first used by Dewar and named after him "Dewar Flasks." These thermos bottles consist of double walled glass containers surrounding highly evacuated space. To further increase the heat insulating power of the flask the inner surface of the outer wall is silvered so that radiant heat from surrounding bodies will be reflected away.

3. The temperature of liquid air (containing about 54% oxygen) is about −190°C. The average temperature of a room is about 20°C. Hence the air is at a burning heat as compared with liquid air. Now

we know that if we throw a piece of hot iron into a tumbler of water, the water will boil until the temperatures adjust themselves. A piece of chalk is about 210 degrees higher than that of liquid air. Hence when thrown into this liquid it should cause it to boil vigorously until the chalk reaches a temperature of $-190°$. And it does in fact. The "magic kettle" filled with liquid air and placed over a cake of ice boils over for the same reason. Yet while the quality or degree of cold of liquid air is fearfully low, the quantity of cold is not so great. The total refrigerating power of a kilogram of liquid air is only slightly more than that of ice. Hence a drop of liquid air will not, as is commonly supposed, freeze a tumbler of water solid.

4. The specific gravity of liquid air is somewhat lower than that of water, it being 0.91 but increases as the nitrogen continues to evaporate.

5. A tube of liquid air shows magnetic properties being attracted by a powerful electromagnet.

Chemical Properties.

1. Cessation of chemical activities: Roughly speaking a rise of 10 degrees doubles the speed of a reaction. For example, if it takes one minute to generate 10 cc of hydrogen gas by the interaction of zinc and sulphuric acid at room temperature (20° C), it would take 2 minutes at 10° C, 4 minutes at 0° C and at $-40°$ C it would take more than an hour. At $-120°$ 10 days would be required and at $-190°$ we would have to wait more than 4 years. Hence even a reaction as violent as that between sodium and sulphuric acid would be slowed down to almost complete inaction. At this temperature fluorine would not attack glass. An Eastman film, however, is still somewhat sensitive at this temperature.

2. A burning stick when plunged into liquid air still continues to burn. Here is a curious example of a fairly high temperature in contact with a terrifically low one. Extremities meet and the reaction goes on. Some danger is involved in such experiments. A lighted candle falling into a bucket of liquid oxygen sent Claude to a hospital in 1903 in a frightful condition.

Consequences of the Extreme Cold of Liquid Air.

1. A rubber ball loses its elasticity, becomes hard and brittle, and is shattered when thrown on the floor.
2. A leaden ball acquires the sonorous property of a bell.
3. Metallic balls show an increased rebound at that temperature.
4. A spring loses its elasticity which it regains when the warm breath is blown upon it.
5. Rubber tubing becomes as hard as a metal pipe and can be pulverized.
6. We can cast a hard hammer head out of liquid mercury immersed in liquid air. The mercury becomes hard enough to drive a nail thru a board.
7. The resistance of metals to electricity is decreased considerably. The resistance of copper is decreased 50 times. Elihu Thomson once jokingly suggested to immerse all our telegraph and telephone wires in liquid air to save power.
8. Our dinners would become very discouraging if we had to eat at this temperature. From soup to nuts a dinner could be relished only by a sword swallower. Think of eating spaghetti as hard as steel cables; an Armour steak would change to an armor-plated delicacy, grapes would be as hard as marbles, an egg would be so hard-boiled as to defy an axe, etc., etc. The flowers on the table would be so brittle that under the slightest pressure they would crumble into dust.

Uses of Liquid Air.

1. Source of Oxygen, Nitrogen, Argon, Helium, etc. During the war a plant was erected at Muscle Shoals for the liquifaction of air from which nitrogen was obtained for the production of nitrates so necessary for explosives and fertilizers.

2. Low temperature experimentation.
3. Perfect drying of gases.
4. Therapeutic value: Pusey, an American, in 1908 was the first to show its value in the curing of skin diseases like eczema and warts.
5. Explosives: Enormous pressures are exerted in the evaporation of liquid air. Cartridges made of granular charcoal and cotton waste when saturated with liquid air have been used as explosives in mining. It is exploded like dynamite by a detonator. A portion of the Simplon Tunnel was dug by this new method.
6. Preparation of Ozone.
7. Production of Vacua: By means of charcoal cooled with liquid air we can evacuate space to as low a pressure as .000015 mm. When we remember that normal atmospheric pressure is 760 mm we realize why even a Crookes radiometer ceases to function in the presence of cooled charcoal.
8. Source of power: Liquid air has been suggested as a source of energy to drive machinery. Submarines, some said, could be driven by it and at the same time the liquid air could supply the crew with the oxygen necessary for breathing. The scheme, however, is economically impossible.

Important uses of liquid air are very limited indeed, yet the importance of this mystic fluid lies more in the fact that it opened up a new field of research on the properties of matter at extremely low temperatures. There is also a sentimental value attached to it, for it has presented philosophical problems. Certain seeds, and microbes in general can quite easily accommodate themselves to the temperature of liquid air, even though 80°C destroys them. During this lecture I froze two gold fish in liquid air and then revived them in water where they continued to swim around for hours afterward with seemingly no very bad results.

Lord Kelvin once suggested that life on this planet may have come from another world from bacteria arriving through interstellar space. The great obstacle to the acceptance of this theory at the time was the extremely low temperature which the organism would encounter on its trip. Today this objection is untenable and Kelvin's suggestion is a serious one. Thus liquid air may hold the key to both the origin of life and the nature of death.

The liquid air used in the experiments during this lecture was supplied by the research laboratory of the Western Electric Co.

DELAWARE PARENT-TEACHER ASSOCIATIONS ARE ACTIVE.

Thirty parent-teacher associations in Delaware report a 100 per cent enrollment; that is, every tax-paying family in these communities is represented in the membership. In 293 school districts of the State 301 associations have been organized. Of the rural districts, 81 per cent have local associations. White associations to the number of 117, and 45 colored associations, have rounded out four years of continuous activity.

These associations have assisted materially in making school health work a success, in beautifying school grounds, promoting musical education, adding to school libraries, providing school lunches, and in encouraging community interest and cooperation in the work of the schools.—*School Life.*

SYSTEMATIC ANALYSIS AND SOLUTION OF QUANTITATIVE PROBLEMS.[1]

By Paul Ligda,
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Introduction

We have three different ways of carrying on our activities: the impulsive and haphazard way, the routine and empirical way, and finally the intelligent and systematic way. For instance:

Suppose that we wish to hit a certain target a given number of times. We may take a rifle, point it in any old direction, shut our eyes and pull the trigger; our main thought being to shoot as fast as possible. Once in a while we will hit the target, thus eventually obtaining the desired result. If we are more thoughtful we may point the gun in the general direction of the target before shooting and also keep our eyes open. Our average score will be higher than if we use the first method. Finally we may shoot carefully, using the sights and studying the effect of each shot.

Problem solving is done in three different ways according to the training of the solver. The average school boy uses a technique developed by the present high-speed, quantity production fad. He reads the problem, grabs a couple of numbers from the statement, adds, subtracts, multiplies, or divides as his fancy dictates, trusting to luck to get the right solution. By means of this method, which, incidentally, is encouraged by "speed tests" and frequent admonitions to "think fast," he can "solve" a large number of problems. In classes blessed with energetic teachers the pupil who attempts the solution of one hundred problems and gets forty correct answers wins a higher grade than the pupil who tries only twenty and gets all the answers correct. The latter may even be told that he is a failure.

When the teacher himself solves a problem he is more careful. After a meticulous study of the problem, he selects an unknown, calls it x, expresses some other numbers in terms of x, and writes an equation. If the solution fails to produce the desired result he repeats the process, using some other combinations of numbers until the right equation is obtained. Then he writes the correct solution in orderly steps, and calls this performance a

[1]The material in this article is mostly taken from the writer's "The Teaching of Elementary Algebra," by permission of the publishers: Houghton Mifflin Company.

piece of reasoning. The reader who does not believe that this empirical way is used by most people is advised to try some of the difficult problems given in mathematical journals. He will discover that he has not any reliable system of solution and that our vaunted reasoning and analysis are nothing but blind gropings, followed by a discussion of the problem *after* it is solved. The teacher usually makes the class study the finished product instead of the manufacturing and assembling process. What we call problem solving ability is mostly persistence in the face of numerous failures, and recollection of similar types.

It is the purpose of this article to examine the third way: the systematic way. A systematic method must be founded necessarily upon a conscious and comprehensive general plan of attack. This plan must be founded upon a knowledge of the structure of problems, of some properties that all problems have in common, and of the derivation of problems. In short, before we can analyze any particular problem, we must be able to analyze the general problem.

Before we proceed to illustrate such analysis, let us examine some of the results of teaching of problem solving by current methods.

The Results of Lack of System

Readers of contemporary educational journals very frequently find articles describing almost unbelievable descriptions of results of tests of problem solving ability, or rather lack of ability. Let us examine a few.

Last winter a high school graduating class of 250 was given an examination containing the following problem among others: If Sam can do a job in 2 days and Jim can do the same job in 3 days, how long would it take them to do the job if they worked together? The various answers justify the statement made at the beginning of this article about pupils grabbing a couple of numbers and using whatever fundamental operation suited them best at the time. Some students answered 0 days, probably having attempted to subtract 3 from 2 and failed in the attempt. Others, obtaining -1 by the same method, interpreted it "less than one day." Still others, more fortunate in their selection, obtained one day, having subtracted 2 from 3. Quite a few obtained 5 days, and some deduced 6 days, the "method" being obvious. The most popular answer was $2\frac{1}{2}$ days—the "average length of time." Only six students gave the correct answer.

The May, 1924, number of Mathematics Teacher contained an article describing the failure of 15 out of 53 first year normal school students to solve the following intricate problem: What is the cost of 1625 pounds of coal at \$15.25 per 2000 pounds? It is hoped that the fifteen will not teach arithmetic to the rising generation.

But the climax has come! Usually only high school training is pilloried in these articles, mostly by persons who do not seem to be familiar with high school population and other conditions. But the December, 1924, number of SCHOOL SCIENCE AND MATHEMATICS contains an article by J. M. Hughes entitled "Shall we mathematize or demathematize physics?" Mr. Hughes assigned the following problems to a class consisting of twenty-six university seniors and graduate students. The mean number of years of training in mathematics of the members of the class was 4.1 years.

(1) $(1+2) \div (x+y) = 1$. Solve for x.

(2) $\sqrt{20} + \sqrt{45} + 1 \div \sqrt{5}$. Combine.

(3) A train leaves a station and travels at the rate of 40 miles an hour. Two hours later a second train leaves the same station and travels in the same direction at the rate of 55 miles an hour. When will the second train pass the first?

(4) A merchant has two kinds of tea, one costing 50 cents and the other 65 cents per pound. How many pounds of each must be mixed together to produce a mixture of 20 pounds that shall cost 60 cents per pound?

Mr. Hughes informs us that: (1) Eighteen students failed to solve any problem properly. (The word "properly" is ambiguous. Does it mean that an arithmetic solution was not acceptable for 3 and 4?) (2) Seven solved problem 3. (3) Four students solved problem 4. (4) These four students had 9, 8, 7½, and 6 years training respectively.

What is the cause of this extraordinary situation? What is the remedy?

Since the beginning of the century we have been deluged by contributions of various investigators, researchers, scientists, thinkers, etc. Each claimed to have discovered the true cause: lack of training of teachers, unsuitable textbooks, mentality of pupils, useless or difficult topics, lack of practicalness of problems, lack of thoroughness in preparation, unpsychological sequence of topics or presentation of subject matter, unscientific determination of objectives, unbusiness-like methods, the fact

that inductive methods were not used, etc. We have taken their advice, trained our teachers until most can discuss Einstein's theory of relativity, cleaned a lot of rubbish out of our textbooks, written new textbooks so cleverly arranged that children do not even know that they are learning anything, etc.

But the situation does not seem to have changed, as evidenced by the results of the tests quoted in this article. If anything it is worse. The old mathematical courses had a frightful mortality, but the survivors certainly knew how to solve problems! In the writer's college days at the beginning of the century there was a junior course in which the final examination consisted entirely of verbal problems. The unfortunates who failed to pass with the grade of satisfactory were not allowed to pursue their studies in mathematics any further, that is, were not allowed to disgrace their alma mater by claiming that they knew mathematics.

The lack of real mental effort is certainly one of the causes of the present day situation. But it is idle to discuss this topic any further, for it is obvious that we have to adapt our methods to modern class room conditions. The spoon-feeding, learn-by-playing, policy is too strongly intrenched to be dislodged by merely talking about it.

Furthermore it is perfectly true that hard work alone, unless intelligently directed, will not produce consistent results. It is perfectly safe to assert that past generations learned mathematics better for the simple reason that a larger percentage worked hard and hence a larger percentage stumbled on the right path by good luck. Severe mental practice in associations will undoubtedly produce facility in associating in the field in which the practice takes place.

But is it barely possible that we have not investigated the true reason? Is it possible that the reason why our pupils cannot solve verbal problems is simply because we do not teach them to solve verbal problems? An army of teachers and authors rises indignantly at the very thought! "Why, we do teach them to solve problems! Our books or courses bristle with problems, scientifically selected, formulated and arranged after extensive research work by the greatest educational authorities in the country and years of trial in hundreds of classes under critical and expert supervision. We assign problems and our pupils solve them pretty well. The great trouble is that too many teachers have not been trained in our methods or are not as conscientious as we are, so that most of our pupils come to us with-

out the proper preparation," and so on ad libitum. The college professor has the best of it in this kind of an argument for his students are seldom criticized, except by business men who know from bitter experience that college graduates are not much better than high or grammar school graduates when it comes to solving simple problems not involving calculus or the functions of a complex variable.

But we return persistently to the charge. "You authors claim that you do teach the solution of verbal problems. Kindly explain how you do it. Show your method, explain it clearly. When a child does not know what to do, does not know whether to multiply or divide, how to obtain an equation, what formula should be selected, what facts in the problem are relevant and what are irrelevant, what do you do?" "I show him *how* I do it. I give him an illustration and instruct him to imitate my method. I tell him that we have problems of different types such as the work problem, the proportion problem, the mixture problem, the uniform motion problem, etc., and that if he learns the various types he will be able to solve problems." Many children follow these directions faithfully, try their level best. But the results of tests speak for themselves.

Let us call spades spades. Present day methods do not develop the ability to solve problems; they merely teach problems. Books do not show by what process people determine what to multiply or divide, or what impels authors to write equations. They do not show the mental process of analysis for one good and sufficient reason: that heretofore none has been published. Quoting the Report of the National Committee on Mathematical Requirements, page 334: "No one has yet had the time to make the detailed study and analysis of the applied problems of algebra which has been made on the mechanical side of the subject." Our researchers are too busy to attend to such trifles.

Some modern textbook writers will indignantly protest the above statements. "Our methods do teach the solution of problems. We develop in the pupil the power to solve problems *inductively*. So many skills and abilities are involved in the process that we cannot explain it in an elementary treatise. The theory of . . . (put here a few paragraphs containing lengthy, sonorous, and meaningless words)—would not be understood. You do not have to know the theory of a process in order to use it effectively." As the quoted tests show, the

authors seem to consider that the word "inductively" is synonymous with "not at all," or "by some haphazard and uncontrolled process," or "out of thin air." If these authors' methods developed power inductively they would do something that Herbert Spencer considered impossible: to associate two factors in the absence of one of the factors from consciousness. A little illustration of inductive methods would not be amiss.

A teacher was visiting a physics class. The professor placed a block of wood in front of each student and told the class to think hard. After a long period of silence the visitor ventured to ask the savant what he expected the class to do. The latter replied that he expected the students to form the concept that matter would not set itself in motion of its own accord. He aimed to develop Newtons! (Quoted from memory from an old number of SCHOOL SCIENCE AND MATHEMATICS.)

Let us speak plainly. It is not reasonable to expect pupils to learn out of thin air something that teachers or authors themselves do not understand well enough to state and explain clearly. Prince Krapotkin's remark would be apropos at this point: "The Russian muzhik can be made to understand the most difficult physical law or political situation, provided the speaker knows what he is talking about and uses words that the muzhik can understand." Psychologists recognize that words that the child can understand must be used when teaching anything, but few educators are willing to acknowledge that they do not know what they are talking about. Quite a few of our contemporary authors of textbooks therefore stand indicted on account of ignorance of the subject when they promise results on their unsupported claim that their methods are natural, pedagogical, scientific, practical, psychological, or business like. Of course the candid and conscientious authors who simply present methods which give them good results without any claims that the latest scientific wrinkles are used are not included in this indictment.

An interesting incident will throw considerable light on the situation. While searching for methods of solution of problems the writer met directions of the following types:

Read the problem carefully.

Represent one of the unknowns by some letter.

Represent all of the others by using the same letter.

By a study of the relations between the parts of the problem express the word statement in algebraic form.

The writer did not quite understand the last. In order to locate the exact trouble he gave a copy of these directions to one of his bright pupils and assigned a few problems. Inside of five minutes the boy came to him with the questions:

"What do you mean by the word "relations"? I would like to know what I am to study. *Show me the relations in a few problems.*

"What *are* the parts of the problem? Give me an illustration.

"How do you express the word statement in algebraic form? What word statement?"

The last question reminds the writer of the ignominious defeat of the star pupil when asked to express "macaroni" in algebraic language!

After thinking it over the writer consulted several mathematics teachers. Some gave evasive answers. Others frankly said that they did not understand the last direction and advised writing to the authors. This advice was followed. Some of the answers may be of interest:

Author 1. No answer.

Author 2. A long winded explanation in highly technical language. The writer confesses his inability to make head or tail out of this particular answer.

Author 3. "If you cannot understand what is meant by such simple words and follow clean cut directions you are not fit to teach mathematics. Use your brain more and your pen less. Study the meaning of words." Ouch!

Author 4. "I must confess that the words used do not describe very clearly what is meant. You know from your own experience that although you may understand something very well yourself, yet you are often unable to transfer the exact meaning to other people. The only advice that I can give you is to make the pupils solve problems while keeping the directions in mind. They will eventually understand the process in the same way as you and I understand it, and the words will become meaningful to them. If you can formulate directions that would make the meaning more clear to the student, I will gladly incorporate your formulation in the next edition of my algebra, and give you due credit for it."

The last author advises teaching students somehow the process of doing a certain indefinite thing without telling them what it is or how it is done. In educational circles this is called an inductive method. It is certainly a labor saving device of high value, at least to authors. Troublesome explanations are clever-

ly avoided by simply stating in the preface that whatever is not explained need not trouble the teacher for it will be learned inductively, because the text has been prepared with such uncanny craft and superhuman skill that the child cannot help but learn what he needs. In letters to administrators this explanation is supplemented by a significant proviso: "Provided the teacher is competent." This clever statement throws the blame of the inevitable failure on the incompetence of the teacher. And the remedy is simple: Hire teachers who have learned the right technique from the author's other publications or from the publications of similar savants. Business methods are certainly being applied to educational problems, at least when it comes to selling and maintaining textbooks!

Let us return to our twenty-six seniors and graduate students. Is it really necessary to study mathematics for half a dozen years in order to solve problems of the type given by Mr. Hughes? If it is necessary, then secondary mathematics as well as college mathematics are in a bad way and the present tendency to remove them from the list of requirements for graduation is justified. Fortunately it is not necessary, as will be shown presently.

Clearly the reason why most of the students failed was because they could not write down the equations after "a study of the relations between the parts of the problem," for it is inconceivable to assume that these students could not solve the extremely simple equations obtained from the problems.

(To be continued)

DISEASES MAKE GREAT INROADS ON CROP YIELDS.

One out of every twelve wagon loads of wheat is the annual loss due to illness of the American wheat crop. The U. S. Bureau of Plant Industry has estimated the yearly loss on account of plant diseases of some of the major crops.

The cotton crop pays even more dearly, for the diseases of the cotton plant levy a payment of one bale out of every eight. Nearly one bushel of Irish potatoes is lost out of every five, and over one bushel of sweet potatoes in every six. Diseases of the corn plant cost about one bushel in eleven.

In five years' time from 1919 to 1924, the loss of wheat from plant disease has dropped from 17 to 9 per cent. Losses in sweet potatoes have dropped significantly from 36 per cent in 1919 to less than 18 per cent in 1922, while cotton conditions have fluctuated from a loss of about 14 per cent to 19 per cent in this time.

Stem rust is the most serious ailment of wheat and rye, while root and ear rot cause most of the damage in corn. Leaf roll is the most important of the many potato diseases.

The host of diseases which menace certain important crops in the United States present a serious economic problem in American agriculture. Plant diseases, together with insect pests, take a large slice out of the national income yearly.—*Science Service.*

CURRICULUM STUDIES ON THE PLACE OF RADIO IN SCHOOL SCIENCE AND INDUSTRIAL ARTS.*

BY EARL R. GLENN,
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and
L. A. HERR,†
Industrial Arts, The Lincoln School of Teachers College,

PART 1: A THREE-YEAR SEARCH FOR A SATISFACTORY SCHOOL RADIO RECEIVER.
PART 2: A RADIO PRIMER FOR PUPIL AND TEACHER.
PART 3: SUGGESTIONS FOR COOPERATIVE CONSTRUCTION WORK IN SCIENCE AND INDUSTRIAL ARTS.

PART I. INTRODUCTION

Our radio experiences began back in the early days of broadcasting when, aside from copper wire and a crystal, our chief equipment consisted of such things as paper clips, shaving tubes, and salt and oatmeal boxes. In those early days, such economy seemed important. The promised instrument might work, and it might not. Therefore every penny was counted. An expenditure of 78 cents for parts was looked upon with some apprehension. No opportunity was lost to use home-made

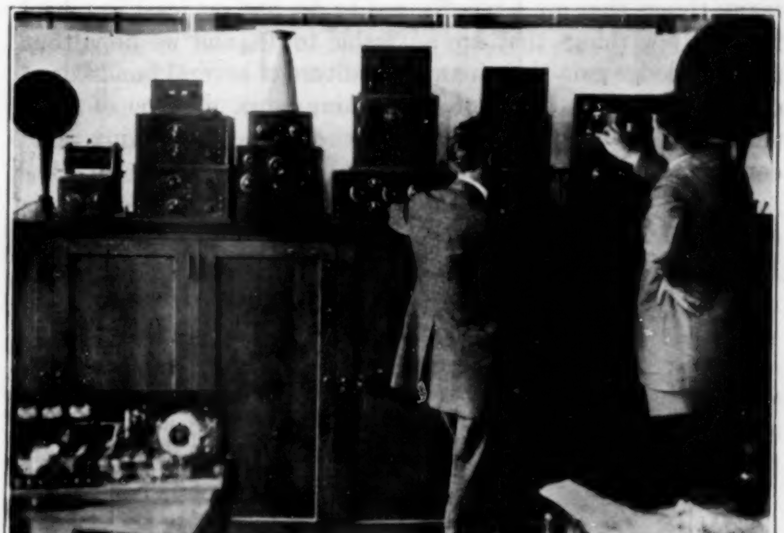


FIG. 1. WHAT RADIO SET SHALL I BUILD? A FEW OF THE RECEIVERS THAT THE AUTHORS HAVE CONSTRUCTED AND ABANDONED

†Practically all of this work was completed while the author was a member of the staff of the Lincoln School.

apparatus. And this was not difficult to do. Newspapers, at about this time, offered daily prescriptions for winding coils, making sliders, and piling up condensers of unknown values and this advice was eagerly sought.

The following account is a record of the efforts of the authors in radio construction, largely from the point of view of school work. These trials, errors, and successes date back to the time when station WJZ was located in Newark, New Jersey, and furnished us with a properly balanced mixture of phonograph music and outstanding headliners. In those days radio was regarded as a curiosity, and while thousands soon became actively interested in it, the innocent bystander wondered whether it was a fad that would soon pass, or whether radio was to be permanent. One by one the newspapers added small radio sections, and in the course of time, these small columns grew to pages and pages. Weekly supplements were then added as regular features of several of the daily papers, and one had to buy his paper early in the day in order to be sure to secure the daily ration of radio diagrams, directions, and programs. At this time any expenditure for radio parts was regarded as a questionable investment but a set which did finally function and bring in barely audible signals was a masterpiece.

In the years that have intervened, we have learned a good many things that are advisable not to do, and, at least in school radio, a few things that are advisable to do, and we hope that the knowledge gained thru an expenditure of several hundreds of dollars and many hours of painstaking work may be of some value, especially to the pupil or teacher who is beginning radio construction.

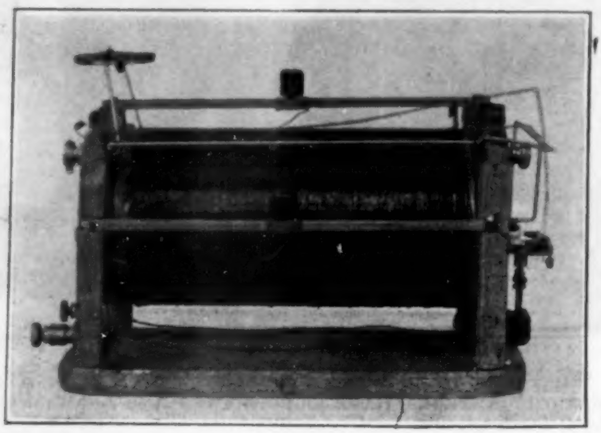


FIG. 2. OUR FIRST RECEIVER RESEMBLED THIS FIRST ATTEMPT OF A SCHOOL BOY. IF YOU LIKE SCRAMBLED RADIO, USE THIS ONE

I. The Crystal Type of Receivers

Figure 1 shows a few of the radio sets that have been constructed by the authors in their search for an ideal receiver for use in school science and industrial arts. In the early days of radio one bought his parts for construction work wherever they could be secured for the least money. The authors do not do this any more. Many of the parts used in our first receivers were purchased from the lowest bidder. The two-slide tuner shown in figure 2 may be regarded as a sample of a set put together with such parts as could be obtained.

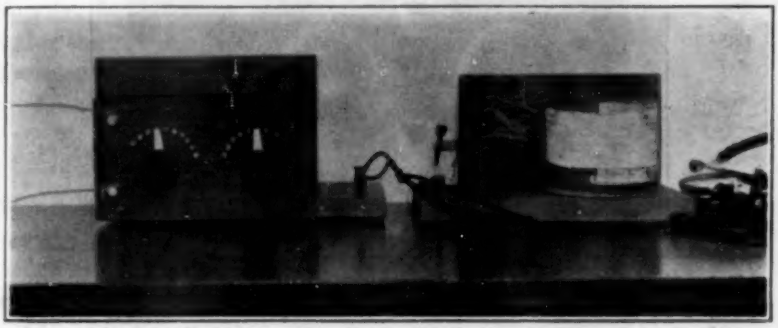


Fig. 3. A "Stone-Age" Crystal Set, Front and Rear View. A Life-saver in its Day—from the United States Bureau of Standards. We Do not Tune with Switch Levers any More

At this period it was a question of getting results with a minimum expenditure of time and money. As the reader will note, this set is fearfully and wonderfully made. On one occasion, when one like it was carried along the street, in New York City in the vicinity of Columbia University, it was followed by a crowd of boys with very much the same interest, apparently, that causes the band to be followed during a holiday parade.

A receiver of this type did give the beginner some satisfaction. With a bed spring for an aerial, it would furnish an evening's amusement for the family and visitors. At about this time the Bureau of Standards came to the rescue of the amateur and published a folder describing a simple crystal set, such as that shown in figure 3.

This was a great contribution in its day. However, we discovered that good telephones were necessary, and to secure such telephones in those days one walked all over New York City in the search for a pair of the Baldwin variety, and usually paid from fourteen to sixteen dollars, cheerfully, after he found them. One of the great advantages of this set is its supposed simplicity.

That is, there are about one hundred and one different tuning combinations, and the question is, which one shall be used?

It was at this stage that the authors discovered that the occupation of adjusting the "cat's whisker" should be added to the census list of "light" occupations. However, unless a radio beginner has used a crystal set in the attempt to get distant stations by a careful adjustment in tuning, and adjustment of the "cat's whisker" he should not be permitted to use one of the

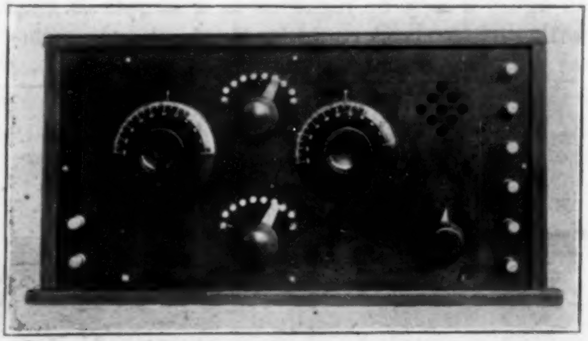


FIG. 4. SINGLE-TUBE REGENERATIVE RECEIVER. A MARVEL IN DAYS GONE BY, BUT WHY USE FIVE OR SIX TUNING DEVICES FOR ONE TUBE?

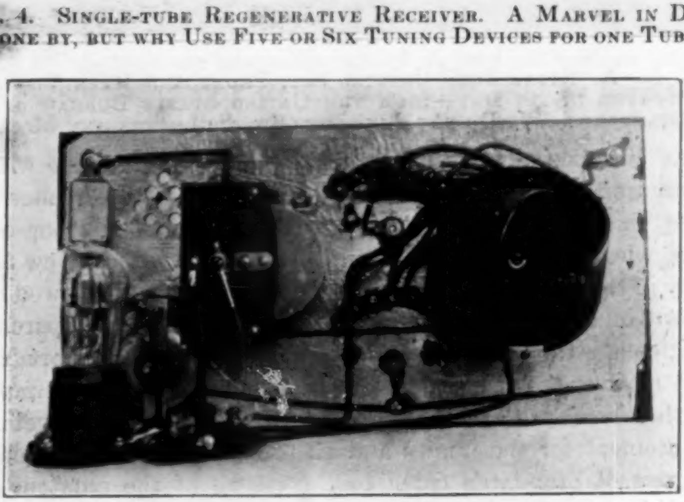


FIG. 5. REAR VIEW, REGENERATIVE RECEIVER. POOR CONDENSERS, TINFOIL, AND SPAGHETTI LOOK FINE BUT LET THE OTHER FELLOW USE THEM

high-power modern radio receivers. But this set did not give sufficient volume or intensity of sound, and it did not bring in the distant stations satisfactorily, so it was abandoned in the search for a better receiver.

II. THE ONE-TUBE TYPE OF RECEIVER

In our next attempts we constructed many different types of

single-tube receivers. The early sets were, in the main, made up of home-made vario-couplers, fixed condensers, etc. One of the first receivers that gave satisfactory results is shown in figures 4 and 5.

This receiver, as we now judge it, turned out to be a fine example of all the samples of poor radio construction that could be crowded into one set. Many taps, poorly adjusted rheostat, impossible condenser, unsatisfactory panel shielding, flimsy socket, and other faults too numerous to mention.

On one occasion we spent the most of three days in trying to discover why the set would not bring in the local stations. Finally, by a chance observation, one summer afternoon out under the shade of the old apple tree, a small piece of tinfoil was discovered that was short-circuiting two binding posts.

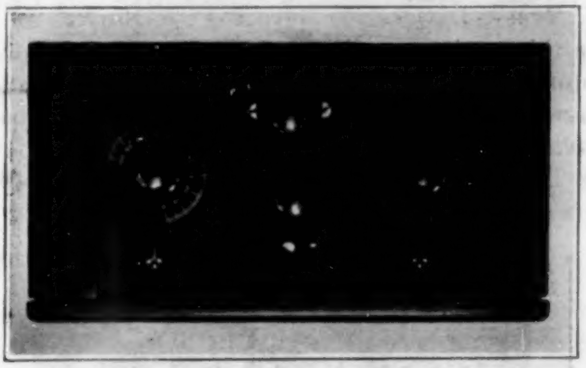


Fig. 6. Another Product of the Saturday Newspaper Diagrams, but two Variometers Failed to Bring the Predicted Results

Although this set had an extraordinary amount of "body capacity," so-called, in spite of its shielded panel recommended to us by the Saturday newspaper supplements, we were able to get fairly satisfactory results. However, it did not satisfy all of our ambitions.

Figure 6 shows another sample of a "newspaper" set constructed by one of the authors in the hope that much better selection of stations could be obtained. However, in spite of patient tuning, none of the sets mentioned in this series satisfied the authors with respect to volume and distance, and so the search was transferred to other types.

III. The Reflex Type of Receiver

We abandoned most of the simple regenerative receivers at this stage in hoping for something more satisfactory. We took one more look at our pocketbooks, and trusting that our ship

would come in some day, gathered up the courage and the necessary parts for a reflex receiver. Having acquired some skill in untangling complicated radio diagrams, we finally put together one of the older types of reflex receivers shown in figures 7 and 8.

FIG. 7. AN EARLY DESIGN OF A REFLEX RECEIVER. WE FOUND NINE TUNING DEVICES TOO MUCH FOR THE NOVICE

When this receiver was built, the authors still believed that satisfactory sockets, variometers, vario-couplers, and fixed condensers, could be constructed with tin cans, salt boxes and easily available materials. The rear view of this set, shown in figure 8, illustrates one of our most successful attempts to construct a vario-coupler. This reflex set contained almost

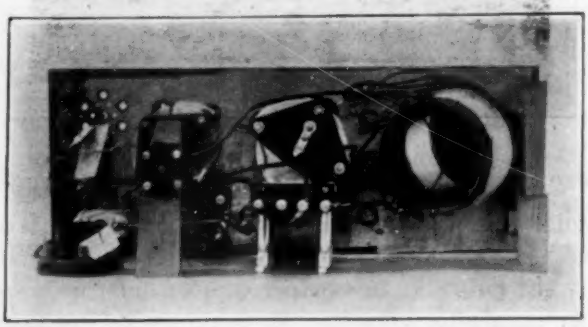


FIG. 8. REAR VIEW OF REFLEX RECEIVER. EVERYTHING BEHIND THE PANEL BUT THE BIRD CAGE

everything except the bird cage, and despite its shielded panel and other outstanding constructional demerits, it was abandoned because it did not bring in any distant stations. It is true that it would give rather superior reproduction of music, and delivered considerably more volume than any set that we had previously constructed, nevertheless, we found it impossible to get the taps, the vario-coupler, the "variable" condensers, and the "cat" to do team work at the same time. And so the search did not end.

IV. The "Lighthouse" Type of Receiver

At this period in our radio evolution the authors agreed that they were either incompetent, or that the articles published by radio writers in most newspapers and magazines were to be taken with a huge grain of salt. Having exhausted our limited funds for accessories, we were still far from our goal of an ideal radio receiver. At this period there was a considerable lull in the enthusiasm for radio construction. However, one afternoon, we came across a newspaper article which seemed to be written by a man who knew what he was talking about. At

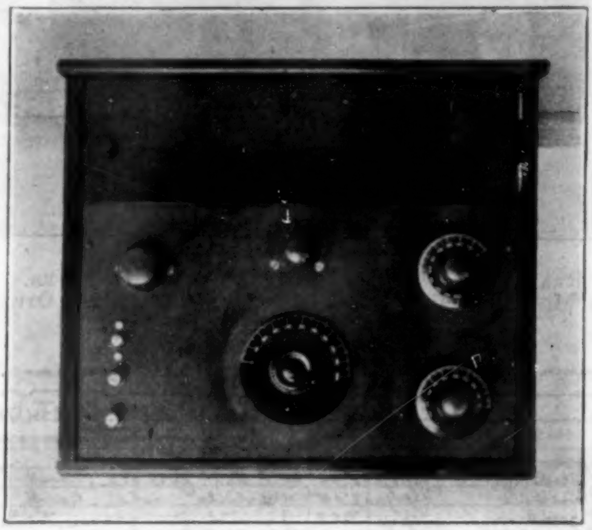


Fig. 9. Tupper's "Lighthouse" Single-Tube Receiver. Fine for Distance but we Had to Sit Still While Tuning

least he knew how to write construction directions, so that they could be read and understood by beginners. This article seemed to us to be more or less of an oasis in a desert of conflicting claims and hook-ups. We therefore decided to take another chance, and after reading carefully Mr. Tupper's directions for constructing what we call the "lighthouse" receiver, we began some more tedious work in winding coils and soldering connections. Views of one of the many sets of this type that we constructed, or that were constructed under our supervision, are shown in figures 9 and 10.

As a single-tube regenerative receiver, we had better success with this than with any other that we had made, or had seen built by our colleagues.

At this stage the authors began to pick up certain points with respect to the differences between "good" and superior radio parts (also radio salesmen), and having become somewhat disgusted with the use of sealing wax as a substitute for first class insulation, we decided that it might be wise to spend a little more for a variable condenser. One evening, we took a gambler's chance on a variable condenser recommended to us by

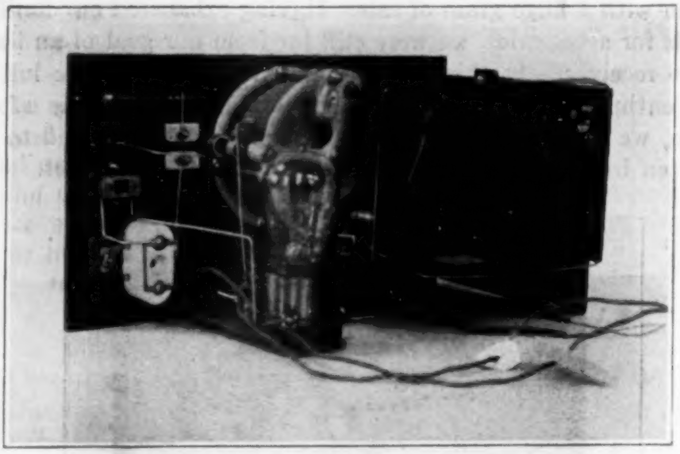


FIG. 10. REAR VIEW OF TUPPER'S "LIGHTHOUSE" RECEIVER. EVERY DIAL MOVEMENT HAS A SQUEAL OF ITS OWN, AND THE OTHER FELLOW HEARS IT

4 inches

RADIO LOG Lighthouse One-Tube Set

Call Letter	*	LOCATION	Distance Miles	Date	Time	REMARKS (Tuning, weather, special feature, quality, etc.)	
WBZ		Springfield		[illegible]	7:30	Eggs, loud	337
KDKA		Pittsburgh		[illegible]	8:00	Market prices, loud	326
WTAM		Cleveland		[illegible]	8:05	marimba solo, loud	350
WJAR	*	Providence		[illegible]	7:28	Jewish program, Fair	360
WOO		Philadelphia		[illegible]	8:30	Orchestra	509
KDKA		Pittsburgh		12/14/23	8:10	Market prices, Very loud	320
WDAP		Chicago		12/14/23	7:40	Signing off. Very loud	370
WCBD		Zion, Ill.		12/14/23	1:00	Choir [illegible] Very loud	345
WGY		Schenectady		12/14/23	10:20	orchestra	380
WDAR		Phila		12/14/23	10:15	dance orchestra, loud	395
WJY		New York		12/14/23	10:35	Tobias, songs, Very loud	405
WLAG	*	St. Paul, Minn		12/14/23	11:05	Trio, orchestra, loud, fading	417
WOC	†	Davenport		12/14/23	11:32	Orchestra, Harding mem. Loud	484
WFAA	○	Dallas		12/14/23	11:42	Allen's orch. Dallas Texas, loud	476

*First time station was heard †-WOC ‡- ○-WFAA• - Earl R. Glavin

FIG. 11. AN EVENING WITH THE "LIGHTHOUSE" RECEIVER. A WORTHY PERFORMANCE WHEN THE NEIGHBORS ARE ALL AWAY ON A VACATION

a radio salesman, and spent six dollars for our first sample of a real variable condenser, which we have since found to be among the best available. Well, the results were marvelous from our point of view, because when this condenser was placed in Mr. Tupper's "lighthouse" set, we were able to do wonders with respect to both distance and selectivity. (To be continued)

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

LATE SOLUTIONS.

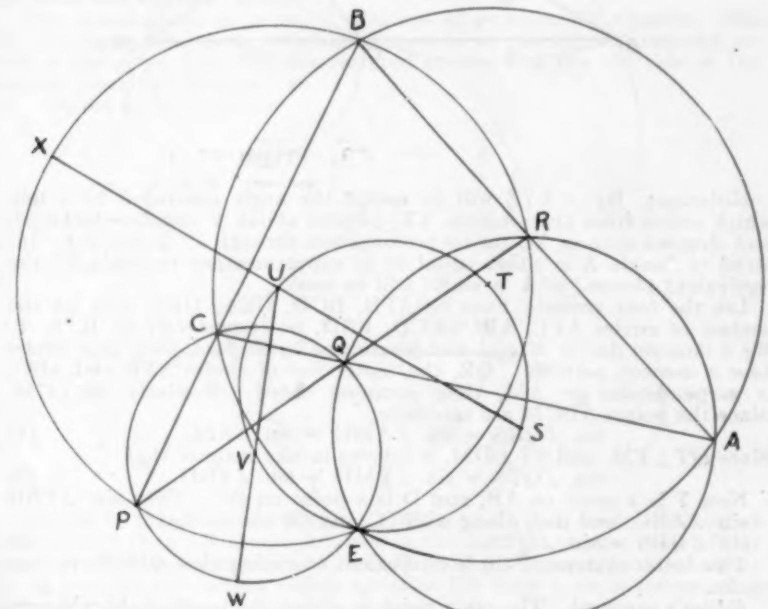
891. *Michael Goldberg; J. Murray Barbour; M. C. E. Lindeque.*
892. *Michael Goldberg; J. Murray Barbour; Melvin Jacobs; Ernest R. Daniell.*
893. *J. Murray Barbour; Charles T. Oergel.*
894. *Michael Goldberg; M. C. E. Lindeque; Melvin Jacobs; W. C. Eberhardt; J. Frank Taylor.*

SOLUTIONS OF PROBLEMS.

896. *Proposed by R. T. McGregor, Elk Grove, Calif.*

The centers of the four circles circumscribed about the triangles formed by four straight lines are concyclic.

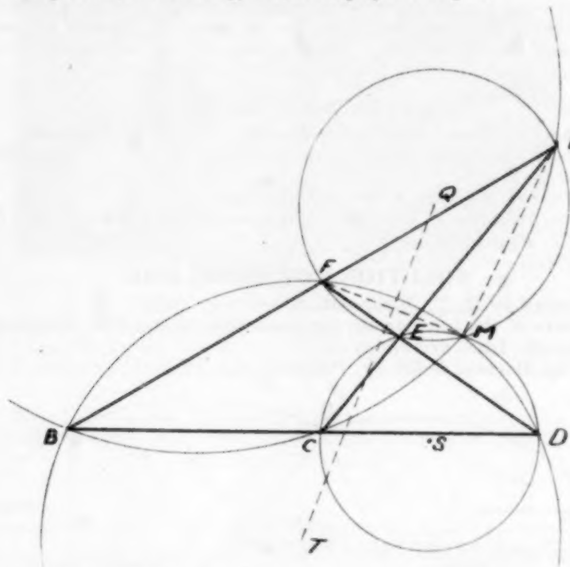
I. *Solved by Michael Goldberg, Philadelphia, Pa.*



Let AB, AC, PR, PB be the four given lines such that the following groups of three points are each collinear, ARB, AQC, PCB, PQR. Draw circles about triangles PRB and PEQ intersecting at E. Then $\angle AQE$ = supplement of $\angle EQC = \angle EPC = \angle EPB$ = supplement of $\angle ERB = \angle ARE$.

Since $\angle AQE = \angle ARE$, the points AEQR are concyclic. Likewise
$$\angle ABE = \angle RBE = \angle RPE = \angle QPE = \angle QCE = \angle ACE.$$
Since $\angle ABE = \angle ACE$, the points ABCE are concyclic. Hence the four circumscribing circles pass through the point E. Let the centers of these circles be S, T, U, V. The line of centers UV bisects the arc EP at W. Then
$$\angle EVW = \angle EQP = \sup \angle EQR = \sup \angle ESX = \sup \angle ESU.$$
Therefore ESUV are concyclic. In a similar manner ESTV are concyclic, and therefore ESTUV are concyclic.

II. *Solved by Norman Anning, University of Michigan.*



Notation: By $\angle XYZ$ will be meant the angle generated by a line which starts from the position YX, rotates about Y counter-clockwise, and stops as soon as YZ (or its prolongation through Y) is reached. Instead of "angle A is either equal to or supplementary to angle B" the equivalent phrase "$\sin A = \sin B$" will be used.

Let the four straight lines be AFB, BCD, CEA, DEF, and let the centers of circles AFE, ABC, ECD, FBD, be respectively Q, R, S, T. *By a theorum due to Miquel and generalized by Clifford, these four circles have a common point M.* QR, the center line of circles AFE and ABC, is perpendicular to AM, their common chord. Similarly $SR \perp CM$. Since the points ABCM are concyclic,
$$\sin \angle QRS = \sin \angle AMC = \sin \angle ABC. \qquad (1)$$
Since $QT \perp FM$, and $ST \perp DM$, it follows in like manner that
$$\sin \angle QTS = \sin \angle FMD = \sin \angle FBD. \qquad (2)$$
Now F is a point on AB, and D is a point on BC. Then $\sin \angle FBD = \sin \angle ABC$, and this, along with (1) and (2) shows that
$$\sin \angle QRS = \sin \angle QTS. \qquad (3)$$
This latter statement (3) is equivalent to saying that QRST are concyclic.

Editor's comment. The main point in giving the proof of this theorem is based upon the fact that the four circles have a point in common. It is not difficult to prove this fact by means of elementary geometry. See Coolidge's "Treatise on the Circle and the Sphere," page 88, theorem 157. The given theorem and several related theorems have attracted much interest. Jacob Steiner mentions them in the Annales de Gergonne, about 1827. Many proofs have appeared in various journals and in many books. In Eugene Catalan's "Theoremes et Problemes de Geometrie elementaires" are found many interesting problems. The following theorems are interesting:

(a). The feet of the perpendiculars dropped from the common point M upon the given lines are collinear.

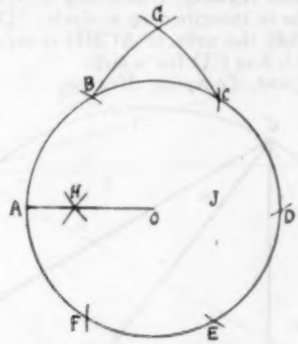
(b). The orthocenters of the four triangles are collinear. For proofs of these theorems see "College Geometry" by Nathan Altshiller-Court.

Also solved by *George Sergent, Tampico, Mexico; Nathan Altshiller-Court, University of Oklahoma; F. A. Cadwell, St. Paul, Minn.*

897. *Proposed by F. A. Cadwell, St. Paul, Minn.*

Using the compasses alone divide a given line segment into two parts, one part being equal to the side of a regular decagon inscribed in a circle whose radius is equal to the other part.

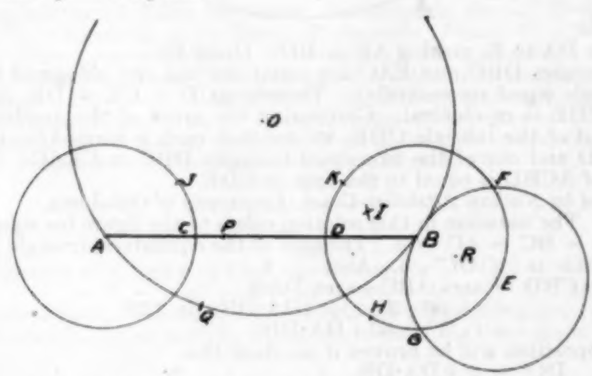
I. *Solved by George Sergent, Tampico, Mexico.*



The formula giving the length of the side of a regular decagon inscribed in a circle of radius R is $(\frac{1}{2})R(\sqrt{5}-1)$. Let a be the given line. Hence, $a = R+(\frac{1}{2})R(\sqrt{5}-1) = (\frac{1}{2})R(\sqrt{5}+1)$. Therefore, $R = (\frac{1}{2})a(\sqrt{5}-1)$. This expression shows that R is the greater segment of the line a divided in mean and extreme ratio.

The construction is given in solution of problem 879, October, 1925 In this figure, the same notation is used as in the solution referred to. OA is the given line, OH the required radius, and HA the side of the regular inscribed decagon.

II. *Solved by the Proposer.*



Let AB be the given line segment. With A and B as centers and equal radii shorter than AB (preferably and in this solution shorter than AB/2) draw circles intersecting AB at C and D. Take any point, as E, on circle B, as a center and with a radius equal to EB draw a circle intersecting circle B at F and G.

By the method used in the solution of problem 658, November, 1920, find H on circle B which shall be a corner of a square of which B and E are also corners.

With F and G as centers and radii equal to HE draw arcs intersecting at I. With C and D as centers and radii equal to BI draw arcs intersecting circle A at J and circle B at K. By the method used in the first solution of problem 860, May, 1925, find O, the point of intersection of the lines

AJ and BK. With B as a center and BO as a radius draw an arc intersecting AB at P. Then AB is divided at P as required.

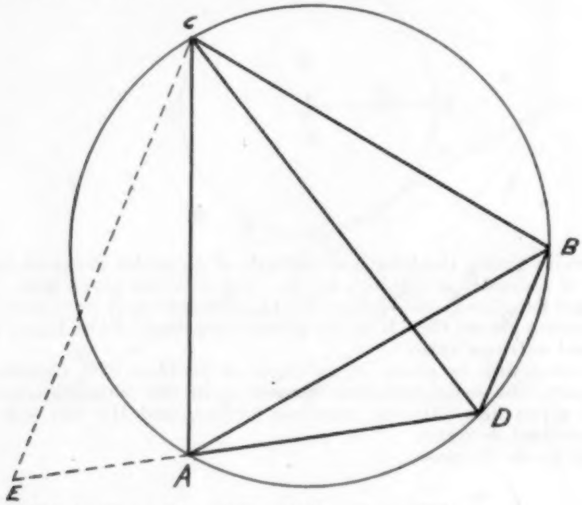
Editor: The proof of this construction is called for in problem 915 (For High School Students).

Also solved by *Michael Goldberg, Philadelphia, Pa.; Leonard Carlitz, Philadelphia, Pa.*

898. *Proposed by Norman Anning, University of Michigan.*

An equilateral triangle is inscribed in a circle. D is any point on the minor arc AB. Show that the area of ACBD is equal to the area of the equilateral triangle which has CD for a side.

I. *Solved by George Sergent, Tampico, Mexico.*



Produce DA to E, making AE = BD. Draw EC.

The triangles DBC and EAC are equal (having two sides and the included angle equal respectively). Therefore CD = CE = DE, and the triangle CDE is equilateral. Comparing the areas of the quadrilateral ABCD and of the triangle CDE, we see that each is formed by the triangle ACD and one of the two equal triangles DBC and EAC. Hence, the area of ACBD is equal to the area of CDE.

II. *Solved by Nathan Altshiller-Court, University of Oklahoma.*

Editor: The notation in this solution refers to the figure for solution I.

Let AB = BC = AC = a. The area of the equilateral triangle having DC for a side is $(\frac{1}{4})\mathrm{DC}^2\sqrt{3}$. Also

$$\begin{aligned}\text{area ACBD} &= \text{area ABC} + \text{area DAB}.\\ &= (\tfrac{1}{4})a^2\sqrt{3} + (\tfrac{1}{2})\ (\mathrm{DA}\cdot\mathrm{DB}) \sin 120^\circ\\ &= (\sqrt{3}/4)\ (a^2 + \mathrm{DA}\cdot\mathrm{DB}).\end{aligned}$$

The proposition will be proved if we show that

$$\mathrm{DC}^2 = a^2 + \mathrm{DA}\cdot\mathrm{DB}.$$

The quadrilateral ACBD being cyclic we have the two relations

$$\mathrm{DC}\cdot\mathrm{AB} = \mathrm{DB}\cdot\mathrm{AC} + \mathrm{DA}\cdot\mathrm{DB},$$

$$\frac{\mathrm{DC}}{\mathrm{AB}} = \frac{\mathrm{DA}\cdot\mathrm{DB} + \mathrm{CA}\cdot\mathrm{CB}}{\mathrm{AC}\cdot\mathrm{AD} + \mathrm{BC}\cdot\mathrm{BD}}$$

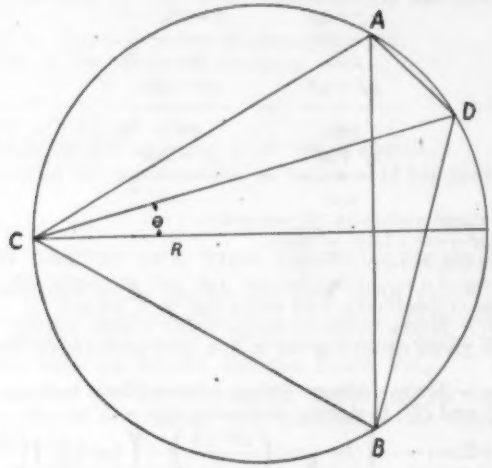
or, replacing the sides of ABC by a and simplifying,

$$\begin{aligned}\mathrm{DC} &= \mathrm{DA} + \mathrm{DB}\\ \mathrm{DC}(\mathrm{AD} + \mathrm{BD}) &= \mathrm{DA}\cdot\mathrm{DB} + a^2.\\ \mathrm{DC}^2 &= \mathrm{DA}\cdot\mathrm{DB} + a^2.\end{aligned}$$

Editor: The second of the above relations for the cyclic quadrilateral will be used later as a problem for solution.

III. *Solved by Michael Goldberg, Philadelphia, Pa.*

If θ is the angle between CD and the diameter through C, and R is the radius of the circle then $CD = 2R\cos\theta$. The area of a quadrilateral is equal to one-half the product of the diagonals and the sine of the included angle.



The area of the quadrilateral

$$ADBC = (\tfrac{1}{2})AB\cdot CD\sin(90^\circ - \theta)$$
$$= (\tfrac{1}{2})R\sqrt{3}\cdot 2R\cos^2\theta$$
$$= \sqrt{3}R^2\cos^2\theta.$$

The area of the equilateral triangle

$$ABC = (\tfrac{1}{4})\sqrt{3}(CD)^2$$
$$= \sqrt{3}R^2\cos^2\theta.$$

Also solved by *Tillie Dantowitz, Philadelphia, Pa.; J. S. Georges, Chicago, Ill.; Elenterio de la Gorza, Brownsville, Texas; F. A. Cadwell, St. Paul, Minn.; James Gardiner, Wilmington, Del.; J. Dinsmoor, Culver, Ind.; H. R. Scheufler, Culver, Ind.; Leonard Carlitz, Philadelphia, Pa.; R. T. McGregor, Elk Grove, Calif.; T. E. N. Eaton, Redlands, Calif.; D. E. Evel, Velma Knox, Harper Rowe, Preston Blair, Roscoe Crim, Jerome Horton, Margaret Lewis, Redlands High School, Redlands, Calif.*

899. *Proposed by Tillie Dantowitz. Philadelphia, Pa.*

$$bx^2+lx+c = 0$$
$$cy^2+my+a = 0$$
$$az^2+nz+b = 0$$
$$xyz = 1.$$

Eliminate x, y, and z and get the equation

$$al^2+bm^2+cn^2+lmn = 4abc.$$

I. *Solved by J. S. Georges, University High School, Chicago, Ill.*

Let (x_1,x_2), (y_1,y_2) and (Z_1, Z_2) be the roots of the three given quadratics, then

$$x_1+x_2 = -\frac{l}{b}, \quad x_1x_2 = \frac{c}{b}. \tag{1}$$

$$y_1+y_2 = -\frac{m}{c}, \quad y_1y_2 = \frac{a}{c}. \tag{2}$$

$$z_1+z_2 = -\frac{n}{a}, \quad z_1z_2 = \frac{b}{a}. \tag{3}$$

The product of the first relations gives

$$x_1y_1z_1+x_1y_2z_2+y_1x_2z_2+z_1x_2y_2+x_2y_1z_1+y_2x_1z_1+z_2x_1y_1+x_2y_2z_2 = -\frac{lmn}{abc}.$$

Using the relation $xyz = 1$, the above equation becomes

$$2+\frac{x_1^2+x_2^2}{x_1x_2}+\frac{y_1^2+y_2^2}{y_1y_2}+\frac{Z_1^2+Z_2^2}{Z_1Z_2} = -\frac{lmn}{abc}. \quad (4)$$

From (1), (2), and (3) we have

$$\frac{x_1^2+x_2^2}{x_1x_2} = \frac{l^2-2bc}{bc},$$

$$\frac{y_1^2+y_2^2}{y_1y_2} = \frac{m^2-2ac}{ac},$$

$$\frac{z_1^2+z_2^2}{z_1z_2} = \frac{n^2-2ab}{ab}.$$

Substituting these values in (4) we get

$$al^2+bm^2+cn^2+lmn = 4abc.$$

II. *Solved by the Editor.*

Solving the given equations for bx^2, cy^2, az^2, multiply left members and right members respectively, and using $xyz = 1$, we get

$$2abc+lmn = -[blmxy+alnxz+mcnyz+ablx+bcmy+acnz] \quad (1).$$

Solving the given equations for a, b, c, and performing the same operations, we get

$$2abc+lmn = -[bcnxy+abmxz+alcyz+bmnx+lcny+almz] \quad (2).$$

Adding (1) and (2) factoring and using $xyz = 1$ we get

$$4abc+2lmn = -\left[(lm+cn)\left(\frac{az^2+b}{z}\right)+\left(bm+ln\right)\left(\frac{cy^2+a}{y}\right)+\left(al+mn\right)\left(\frac{bx^2+c}{x}\right)\right] \quad (3).$$

Using the original equations to simplify each of the second quantities, and combining gives the required relation.

900. *Proposed by C. E. Githens, Wheeling, W. Va.*

A and B are at different points on a straight road. A travels toward B, and reaches B's original position 11 minutes after B had left. B travels toward A, and reaches A's original position 15 minutes after A had left. Each then start back, and meet half-way at 4 P. M. When did each start?

Solved by Frank R. Smith, Lewis and Clark H. S., Spokane, Wash.

The rate of A and B must be regarded as being constant, so that the distance passed over is proportional to the time.

Let x = number of minutes past noon when A starts.

y = number of minutes past noon when B starts.

$\frac{2}{3}(240-x)$ = time it takes A to arrive at B's position.

$\frac{2}{3}(240-y)$ = time it takes B to arrive at A's position.

Hence,

$$x+\tfrac{2}{3}(240-x) = y+11$$
$$y+\tfrac{2}{3}(240-y) = x+15.$$

Solving these equations for x and y, we get

x = 219 minutes past noon, or 3:39 P. M.

y = 222 minutes past noon, or 3:42 P. M.

Also solved by *Preston Blair, Jerome Horton, Redlands, Calif.; Tillie Dantowitz, Philadelphia, Pa.;* and the *Proposer.*

PROBLEMS FOR SOLUTION.

911. *Proposed by Victor A. Ivanhoff, Pittsburgh, Pa.*

Solve the given equation for integral values of x, y, and z.

$$\sqrt[3]{x^3+y^3+z^3} = (\tfrac{1}{2})(x+y+z).$$

912. *Proposed by Nathan Altshiller-Court, University of Oklahoma.*

If the distances of the vertices of a triangle from two given points are proportional, the two points lie on a diameter of the circumscribed circle of the given triangle.

913. *Selected.*

If n is any positive integer greater than one, show that the continued product

$$2 \cdot 6 \cdot 10 \cdot 14 \cdot \cdot \cdot \cdot \cdot \cdot \cdot (4n-6)$$

is divisible by factorial n. For what values of n is the quotient an odd number?

914. *Proposed by Leonard Carlitz, Philadelphia, Pa.*

Find the value of the continued product,

$$\frac{2}{\sqrt{2}} \cdot \frac{2}{\sqrt{2+\sqrt{2}}} \cdot \frac{2}{\sqrt{2+\sqrt{2+\sqrt{2}}}} \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \text{ to infinity.}$$

915. *Proposed by the Editor. (For High School Pupils.)*

Give the proof of the construction of Solution II for problem 897 (in this issue).

NO LAND IN ARCTIC SEA TIDE OBSERVATIONS INDICATE.

Tidal observations made during the long three years' stay of the "Maud," Capt. Roald Amundsen's ship, in arctic ice north of Siberia indicate that there is no arctic continent or land mass in the great unexplored area between Alaska and the North Pole.

This was revealed by Dr. Harald U. Sverdrup, in charge of the scientific work of the expedition, who lectured to the Carnegie Institution of Washington.

Using an electrical recording current-meter designed and constructed on board the ship, Dr. Sverdrup made observations at the Bear Islands over a period of 14 months. He discovered that the tidal wave reaches those islands off the north coast of Siberia in such a way that it "seems to come directly across the Arctic sea without meeting obstructions formed by land."

The Maud left Seattle on June 3, 1922, to penetrate into the drift-ice north of Bering Strait and, if possible, to be carried by it across the Arctic Sea to the vicinity of Spitzbergen, Dr. Sverdrup explained. Closed in by the ice at Wrangle Island on August 8, 1922, the Maud drifted two years west?northwest to the region north of the New Siberian Islands. In an attempt to return to Nome, Aalska, in 1924, the vessel was again caught in the ice at the Bear Islands, 800 miles west of Bering Straits, and it was not until August 22, 1925, that Nome was finally reached.

Dr. Sverdrup explained that the principal object of the expedition was to make scientific observations of terrestrial magnetism, weather, and Aurora Borealis, sea depth, temperature and air currents.

By means of small balloons the air currents of the upper part of the atmosphere over the Arctic were studied. The temperature of the air from the ice to an altitude of about 6,000 feet was studied directly by recording instruments lifted by kites.

"The most interesting result of these observations is that the temperature in winter is always lower close to the ice than at an altitude of 1,000 feet," Dr. Sverdrup said. "The lowest temperature is found at the ice during calm weather."

The lowest natural temperature that can be attained in the region visited by the Maud is minus 50 degrees Fahrenheit, Dr. Sverdrup found as a result of observations which indicated that the heat lost to the upper air and gained from the warmer sea water below would equalize at that temperature.—*Science Service.*

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS ANNUAL MEETING, FRIDAY, NOVEMBER 27, 1925.

The work of this Association during the past year has been conspicuous because of the untiring efforts of officers and chairmen of committees to accomplish four things: 1. To have the programs printed and distributed earlier than usual. 2. To increase the attendance at the general meetings. 3. To increase the attendance at the section meetings. 4. To have excellent programs in both general and sectional meetings. I believe you will agree with me, that these four aims have been accomplished to an unusual degree as indicated by the very large attendance and the excellence of all the programs at this, the Quarter-Centennial Meeting, held at the University of Chicago.

In discussions at the various Executive Committee meetings during the year, there has been an increasing conviction on the part of many of the members that the organization would profit by a little greater centralization of activities, and by increasing the period of service of the chairman of the Membership Committee. With officers and chairmen of committees changing in the Association as much as they often do from one year to the next, there is necessarily a great loss of effort and accomplishment.

At the Friday morning session, the 450 members and guests present had the pleasure of being welcomed by President Max Mason of the University of Chicago. They were then delighted with the addresses which followed: "The Intelligence of Animals—Personal Experiences," by George F. Morse, Director of the new Chicago Zoological Park and the Shedd Aquarium and "Light Waves and Light Quanta" by Dr. A. H. Compton, University of Chicago. The two addresses differed greatly in character, but each made a strong appeal.

The afternoon sectional meetings were well attended. The approximate numbers attending were: biology 32, chemistry 60, general science 53, geography 28, mathematics 100, and physics 75. The programs were well received. Minutes of the meetings and many of the papers given will be printed in SCHOOL SCIENCE AND MATHEMATICS.

Following the afternoon meetings, exhibits were examined, a conducted tour of the University buildings was made, and a reception honoring past Presidents was given. Innovations occurred during the day in the form of badges, flowers, apples and cider.

Over one hundred members attended the dinner given at the University Commons. The following eleven out of a possible seventeen past Presidents were present as guests of honor: Messrs. C. H. Smith, C. E. Comstock, J. H. Smith, H. E. Cobb, Willis E. Tower, C. E. Spicer, H. R. Smith, Jerome Isenbarger, Walter H. Hart, Clarence L. Holtzman, and Miss Marie Gugle. To its Presidents the Association is greatly indebted not only for the service rendered while in office, but also because of the continued service as members of the Executive Committee. That the Association has become in twenty-five years one of the largest, if not the largest, of its kind in the United States is in a large measure due to the inspiration and guidance of its Presidents. The after dinner speaker, Dr. Gerald B. Smith, of the University of Chicago, in his address on "Are Science and Religion Incompatible" assured us that everywhere theologians are ready to become informed about and to accept the teachings of science. But he also impressed upon us the fact that upon us as scientists rested the responsibility of making the general public feel that we, too, are interested in and in sympathy with the teachings of Christianity.

In the absence of Mr. Scopes, it was the wish of the Association that the Secretary express to Mr. Scopes its appreciation of his ef-

forts in behalf of science during the recent controversy on Evolution. Dr. Rollin Chamberlain of the University of Chicago next entertained the members of the Association with an interesting account of his experiences in mountain climbing in the Caraboo Mountains.

For the success of this annual meeting the Association is indebted to many: the speakers, the officers of the sections and the general officers, Mr. W. F. Roecker, Chairman of the Membership Committee, Mr. Charles Leckrone, Advertising Manager, Mr. O. D. Frank, Chairman of Local Arrangements, and for the general program, the excellence of all arrangements, and the many courtesies extended by the University of Chicago, the Association is greatly indebted to its president, Dr. Elliot R. Downing.

SATURDAY, NOVEMBER 28.

The annual business meeting was called to order at nine o'clock by the President, and the following reports were given: The minutes of the Annual Meeting were read by the Secretary and accepted as read. The annual report of the Treasurer, Mr. W. G. Gingery, Shortridge High School, Indianapolis, Indiana, indicated that the financial condition of the Association is satisfactory. There is a balance of $257.15 on hand with most of the bills for this meeting already paid and about half of the bills for the advertising still to be collected. He reported 212 new members, 40 more than the number of last year.

In the absence of the Chairman of the Auditing Committee, Mr. Frank B. Wade, Mr. Joel W. Hadley reported that the accounts were correct and the Treasurer's books approved by the committee.

Dr. Downing gave the report for the Advertising Manager, owing to the absence of Mr. Charles Leckrone. The year book contains 53 advertisements, totaling $806. Thirty-two of the 53 advertisers have paid for their advertisements. $14.00 per page is the present price charged. This also entitles advertisers to space for exhibition purposes. All requests for space were refused to firms and companies not advertising. It was the opinion of the members present that more than $14.00 per page could be gotten another year.

The Chairman of the Nominating Committee, Mr. Wm. H. Atwood, State Normal School, Milwaukee, Wisconsin, reported nominations as follows: President, Frank E. Goodell, West High School, Des Moines, Iowa; Vice-President, E. R. Breslich, School of Education, University of Chicago, Chicago, Illinois; Secretary, Ada L. Weckel, Oak Park and River Forest Township High School, Oak Park, Illinois, was elected last year for a period of two years; Treasurer, W. G. Gingery, Shortridge High School, Indianapolis, Indiana; Assistant Treasurer, Clyde H. Krenerick, North Division High School, Milwaukee, Wisconsin; Corresponding Secretary, Winnafred Shepard, Proviso Township High School, Maywood, Illinois. The report was approved and the Secretary was instructed to cast the unanimous ballot for all nominees.

Chairman of the Membership Committee, Mr. W. F. Roecker, Boys' Technical High School, Milwaukee, Wisconsin, reported that 4,100 programs had been sent out this year. In a membership drive he attempted to cover states, large cities, small cities, in each case placing in charge some responsible, interested person. In some instances it was difficult for him to find such a person. He will welcome suggestions from members. He called attention to the importance of more accurate records which should be passed on by the chairman to his successor. There will thus be a cumulative effect, and not as at present, a loss of effort from year to year.

The report of the Committee on Resolutions was read by the Chairman, Mr. Glenn Warner, Englewood High School, Chicago, Illinois. The report will be printed in full elsewhere.

Mr. H. E. Cobb, Lewis Institute, Chicago, Illinois, as Chairman of the Necrology Committee, reported the death of Mr. Locke E. Lunn, Superintendent of Schools, Heron Lake, Minnesota. This report will be published in full. The Secretary was instructed to send a copy of this report to the widow of Mr. Lunn.

Under General Business, several matters of importance were considered. After discussion, a motion was carried to appoint the Chairman of the Membership Committee for a period of three years, instead of one as at present. A motion was also carried to add to the present duties of the President that of Advertising Manager.

Miss Ulrich, High School, Oak Park, Illinois, gave a brief report of the results of her efforts as Chairman of the Geography Section to revive interest in that section and increase the attendance. Twenty-eight, instead of the usual six or eight, were present. Her results were, therefore, not all negative.

The following bills were approved for payment: Geography Section, $33.36. Permission had previously been given this section to use more than the allowed $25.00 in order to send out a questionnaire in the interest of the members of the section. Treasurer's expenses, $39.41.

A motion was next carried to the effect that in the opinion of the members present admission to the meetings next year should be to members only. The final decision, however, to rest with the Executive Committee, to whom the matter was referred.

The Business Meeting was then adjourned.

At ten o'clock the All Science Section Meeting was called to order at Kent Theater. The several hundred members present listened with great interest and profit to the following excellent program: "Recent Work on the Ether-Drift," Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio, President of the American Physical Society; "Survey of Recent Progress in Botanical Research," Dr. Merle Coulter, University of Chicago; "Demonstration of Atom Collisions," Dr. W. D. Harkins, University of Chicago; "The General Science Course," Charles H. Lake, Assistant Superintendent of Schools, Cleveland, Ohio.

The meeting adjourned at twelve thirty.

ADA L. WECKEL,
Secretary.

REPORT OF NECROLOGY COMMITTEE.

November 28, 1925.

On June 18, 1924, while engaged with his duties in the school building, an attack of heart failure brought to a swift close the lifework of Mr. Locke E. Lunn, Superintendent of Schools, Heron Lake, Minnesota.

In preparation for his professional work he had pursued courses of study in Drake University, the University of California, and the University of Minnesota. Among the positions he held are: Principal of High School at Earlham and Des Moines, Iowa; assistant in Physics and Chemistry, Drake University, one year; Superintendent of Schools, De Smet, South Dakota, four years; Superintendent of Schools, Heron Lake, Minnesota, nine years.

His death came as a great shock to his wife and four children. His record as a teacher and superintendent shows that he loved his work, and left in the minds of his pupils memories of an able teacher and a sincere friend.

(Signed),
H. E. COBB, CHAIRMAN,
W. G. GINGERY.

REPORT OF THE COMMITTEE ON RESOLUTIONS.

Resolved: That the Central Association of Science and Mathematics Teachers extend its sincere thanks to the Trustees of the University of Chicago for the use of the buildings and grounds for its twenty-fifth annual meeting; and to the president and the other officers of the University, to the faculty and to the students its appreciation of the kind hospitality and many courtesies shown its members.

Resolved: That the Association express its deep gratitude to President Max Mason, Dr. A. H. Compton, Dr. Gerald B. Smith, Dr. Rollin Chamberlain, and Dr. George F. Morse, for the excellent addresses delivered at the general sessions; and to the many other speakers who have contributed to the success of the section programs.

Resolved: That the Association tender its appreciation to Mr. O. D. Frank, Chairman of the Local Arrangements Committee, and to his assistants for the complete provisions they have made for the comfort and convenience of its members; also to the Reynolds Club for the use of their rooms, and to the management of the University Commons for the excellent luncheon and dinner.

Resolved: That the Association express its thanks to the retiring officers for their untiring efforts, especially to Professor Elliot R. Downing, whose work has made this a banner year, and to Mr. W. G. Gingery, who has faithfully discharged the duties of Treasurer for the past two years.

Resolved: That the Association deplores the tendency in some states to impede the progress of science by erecting legal barriers to the proper presentation of well founded theories which lead to new discoveries and further advancement in scientific knowledge and civilization.

GLEN W. WARNER,
G. B. EISENHARD,

MINUTES OF THE GENERAL SCIENCE SECTION.

The meeting of the General Science Section of the Central Association of Science and Mathematics Teachers was held in Room 13 of the Botany Building of the University of Chicago, Friday, November 27, at 1:30 p. m. Mr. H. P. Harley of the Fairmont Junior High School, Cleveland, Chairman of the Section, presided.

More than twice as many members as were present at the meeting of the Section a year ago enjoyed an unusually interesting program. Complete and elaborate reports were made by all four of the special committees: The report for the Committee on New Apparatus for General Science was given by the Chairman, Mr. Ira C. Davis, of the University of Wisconsin High School, who presented the results of a recent investigation to determine the apparatus needed for a course in general science, as prescribed by the ten most widely used textbooks in the field. Interesting pieces of apparatus were also displayed as a part of this committee report.

In the absence of the committee chairman, Professor Hanor A. Webb, of George Peabody College for Teachers, the report for the Committee on New Books and Articles in the Field of General Science was given by its other member, Mr. Francis D. Curtis, of the University of Michigan. Reprints of Dr. Webb's extensive bibliography, recently published in the *Peabody Journal of Education* for October, 1925, were distributed and a brief summary was made by Mr. Curtis of the outstanding books and articles in the field, published during the past year.

All four members of the Committee on New Curriculum Units reported. The Chairman, Mr. E. S. Obourn, of the John Burroughs High School, St. Louis, presented the results of an extensive investigation of new curriculum units determined from an examination of

the text-books and literature. Mr. E. B. Collette, of the Lake View High School, Chicago, stressed the need for keeping young in the work; and to avoid monotony in presenting general science courses, he advised a study of the individual pupil and of the particular environment of the school. A conservative point of view with respect to the idea of expanding further the curriculum for general science by the addition of new units of uncertain or undetermined value, was expressed by the other two members of the committee: Mr. W. F. Roecker, of the Boys' Technical High School, Milwaukee, urged a retrenchment, an elimination of some of our present units, in order to secure a better mastery of the curriculum elements offered; Miss Anna P. Keller, of the Lake View High School, Chicago, also spoke in favor of fewer new units and better work upon the older ones, particularly hygiene.

In the absence of both members of the Committee on Research in the Field of General Science, Mr. Earl R. Glenn, of the Lincoln School of Teachers College, New York, and Dr. S. R. Powers, of Teachers College, the report of the Chairman was read by Mr. Obourn. Mr. Glenn's paper summarized in able fashion the most important investigations in general science during recent years.

Mr. Paul I. Pierson, of the Chicago Normal College, presented a very interesting paper upon "Planning the General Science Recitation," in which he made excellent practical use of educational psychology in establishing his points.

The principal paper for this Section was that of Mr. Charles H. Lake, First Assistant Superintendent of Schools, Cleveland, given at the Saturday morning session. Mr. Lake presented an interesting survey of the present and probable future status of general science in the grades and in the high school.

The following officers were elected for the coming year: Chairman, Mr. W. H. Atwood, of the Milwaukee State Normal School; Vice-Chairman, Mr. Francis D. Curtis, of the University High School, Ann Arbor, Michigan; Secretary, Miss Anna P. Keller, of the Lake View High School, Chicago.

FRANCIS D. CURTIS,
Secretary.

MINUTES OF THE MATHEMATICS SECTION, CENTRAL ASSOCIATION.

The Mathematics Section of the Central Association of Science and Mathematics teachers met Friday afternoon, November 27, 1925, in The Little Theatre, Reynolds Club, University of Chicago.

The Chairman, Dr. Raleigh Schorling, presided. The first paper to be presented was by Miss Mary Potter, Supervisor, Racine, Wisconsin, on "Individual Instruction in a Course in Demonstrative Geometry." Miss Potter told of the plan which has been used in Racine High School for four years in which each theorem is presented as an original exercise. The pupils have no text book, but instead a loose leaf notebook containing the mimeographed statement of the theorems with blank space beneath for the figure, hypothesis and conclusion. The proof is filled in by the student on a sheet of theme paper facing this mimeographed sheet. A separate notebook is provided for each semester and at the end of this time it is handed in to the teacher and not returned. The pupils are introduced to geometry in the customary way through development of definitions, postulates and constructions. This is followed by a transition period of socialized recitation. As the pupils advance, those who have made perfect recitations in certain theorems are frequently called upon to act as student teachers and to hear other pupils recite these theorems. General class recitations are not omitted. About one-third of the

time is spent on class recitation, drill, and two to five minute tests, with the remaining two-thirds on study and individual recitation.

The Racine High School is operated on a weighted credit system; thus different standards of attainment are made for the different grades which the students desire to earn. The work in geometry is assigned by units which must be completed within a specified time; a two weeks' period has been found very satisfactory. Usually the student receiving the highest grade does twice as much work as the one whose grade is lowest.

This individualized method of geometry instruction has been found very satisfactory in Racine as evidenced by the record made in the Schorling-Sanford Geometry Tests in which the median was more than 25% above the standard.

The second speaker on the program was Prof. W. W. Hart of the University of Wisconsin whose topic was "The Wisconsin High School Plan of Trying to Educate to Capacity in Mathematics." The plan as outlined by Prof. Hart consists in dividing the material to be covered by the class into three blocks:

1—The minimum block, the "fair" contract consisting usually of the propositions and corollaries and a few exercises. This is designed for the weaker student.

2—The "good" contract which embraces all of the "F" contract and includes additional exercises.

3—The "excellent" contract including the first and the second with supplementary exercises chosen from a section in the back of the book.

Prof. Hart advised a short period of time for a contract because of the tendency of pupils to procrastinate. There are three steps in a contract; first, the preview—the rapid running over of the main theorems in which the better students do most of the work; second, the view—gcing over the work with the slow pupils and third, the

period of summary which is designed to pull the pupils together. In each contract the pupil must work for mastery. Prof. Hart advised a minimum of recitation, the pupils writing out their contracts, as he believed it better for the pupil to go ahead and work for himself then to act as teacher.

In order that there shall be evidence that the pupil has mastered his contract, three examinations are given: the fair test, the good test and the excellent test.

The next paper, "Individualized Instruction in the First Year of Algebra" by Miss Selma A. Lindell, of the University High School, University of Michigan, was an account of an investigation that Dr. Schorling and she are conducting in the teaching of skills in ninth grade algebra. The purpose of this study is to measure the effect of applying certain principles from the psychology of drill. Some of the principles stated by the speaker were:

1—The pupil must have a thorough understanding of the process before the drill.

2—The drill should be diagnostic.

3—There should be much practice on a few skills rather than a little practice on each of many things.

4—Effective drill must be individual.

5—A drill exercise should be standardized in order that the pupil may have some notion of his degree of skill.

A booklet entitled "Instructional Tests in Algebra" consisting of fifty-two goals and adjusted for pupils of varying abilities is used by the teachers taking part in the experiment. All of these teachers must teach at least two classes, one of which will be conducted on the usual plan in that city. In the experimental class ten minutes will be taken each day at the beginning of the hour to use the booklet. An algebra test was given to all the classes taking part in the experiment early in the school year and comprehensive tests will be given to them at the end of the year.

At the conclusion of this paper the Chairman called for the Secretary's report which was read and approved. The report of the nominating committee consisting of Mr. O. M. Miller Chairman, Miss Rose G. Friedman, and Mr. Wm. Beck was then called for. They reported as follows: Mr. E. W. Owen, Oak Park, Chairman; Mr. Joseph Nyberg, Hyde Park High School, Vice Chairman and Miss Blanche Clark, Rockford High School, Secretary. The report of the nominating committee was accepted and the officers elected.

As there was no further business, the program was continued.

"What May be Done by Way of Diagnosis and Remedial Treatment in Arithmetic" was the subject of the next speaker, Mr. Leroy H. Schnell of Tappan Junior High, Ann Arbor, Michigan. Mr. Schnell summarized the work of outstanding investigators in the field of diagnosis and remedial treatment. The writings of Paulu, Courtis, Monroe, Woody, Devos, Stevenson and others were carefully reviewed. The need of diagnostic tests, their function in locating the difficulties of pupils and how they may be used to guide corrective and remedial measures, were emphasized by the speaker.

The general discussion of the topic, individual instruction, was opened by Prof. Breslich of the University of Chicago High School. Prof. Breslich spoke of the change in methods of instruction from the individual instruction of early times to group instruction as education became more popular, and of the present tendency to go

back to individual instruction. He touched upon other methods used at the present time—grouping according to ability and the supervised study plan, to both of which he considered the method of individualized instruction, preferable.

Mr. Joseph Gonnelly, in charge of the Chicago Junior High Schools continued the discussion bringing out the danger of exclusive individual instruction in minimizing the importance of socialization and advocating a combination of social and individual instruction as the solution of the problem.

Mr. Edwin Schreiber of Proviso Township High School, Maywood, closed the discussion urging the teachers not to become so absorbed in the mere machinery that they forget the worth-whileness of individual life. He gave three suggestions:

1—To read "Talks to Teachers" by Wm. James.

2—To become better acquainted with boys and girls.

3—To become familiar with a few examples of good teaching in the past by reading Cajori's story of Wm. Oughtred; the life of Rene Descartes, and life of Alice Freeman Palmer written by her husband.

A. Blanche Clark,
Secretary.

PHYSICS SECTION MEETING

On Friday afternoon, November 27, the Physics Section of the Central Association of Science and Mathematics Teacher met in the Ryerson Physics Laboratory. The meeting proved very interesting and was well attended, there being approximately one hundred present.

Dr. Gale, of the University of Chicago, gave an enlightening talk on "Recent Developments in Optics." He pointed out that in 1911 our modern theory of atomic makeup was first worked out by scientists. He showed the electron and proton structure of the atom, showing that the important properties of atoms depended upon the electrical charge on the nucleus and not the weight of the atom.

Professor Stewart of Iowa University then talked on the practical application made through late experimental work on sound. He showed how sound could be used to determine the depth of the ocean and how it could be used to locate aeroplanes in case of war. He also explained Dr. Dewitt's invention of a loud speaker diaphragm which does away with the resonance of frequency of the dial itself.

Mr. Frank A. Goodell of Des Moines, Iowa, then talked on the "Changing Methods of Physics Teaching." His talk was practical and gave the teacher much to think about. He distributed a questionnaire which he had used in making a study of methods used in the teaching of physics and discussed the results.

Mr. Earl E. Glenn was unable to be present.

Mr. N. Henry Black of Harvard University then introduced his new type of physics test. He came to Chicago to be able to present his test to mid-west science teachers. Though the study is still being made, Mr. Black would like to have those interested send for the test and try it in high school physics work as part of the final examination. He showed that testing was an important factor in all teaching. The papers given at the meeting are duly summarized here but will appear in current issues of School Science and Mathematics. The report of the Nominating Committee was then read by

Mr. Clyde Krenerich of North Division High School of Milwaukee. It was accepted.

The following officers were elected for the year: President, R. H. Struble, East High, Detroit, Mich.; Vice-President, M. J. W. Phillips, West Allis, Wis.; Secretary, J. M. Kurtz, Bowen H. S., Chicago, Ill.

President E. E. Burns, of Medill High School, Chicago, then led a discussion in which the following took part:

Mr. J. B. S. Baker questioned the results obtained in physics as compared to those obtained in other courses. He wondered whether there was a lack of attention and study in school work due to the large number of outside activities that are now found in every school. Mr. Baker thought that teachers in every course had to cope with the same problem—that of getting a more serious consideration of school work by the pupil.

R. H. Struble, of Detroit, stated that physics compared well with other courses. He said that those poor in arithmetic were generally poor in physics, those good in mechanical drawing did good work in physics. Mr. Struble also said that the English and science departments could work well together in the writing of topics on scientific subjects.

Mr. Gould, of Central High in St. Louis, questioned Mr. Black of Harvard as to how tests could be interpreted and marked uniformly. He said that many standardized tests were hard even for the teacher to interpret.

Mr. Black stated that the practical viewpoint should be taken in making a correct explanation. He also stated that many took physics who were not fitted to master the subject. He suggested the giving of a diagnostic test to serve as a thermometer of the students' capacity in physics before allowed to take the course. Such a test should be based on aptitude in geometry and arithmetic, ability to read the meaning of a paragraph, and the practical background for the course.

Mr. Eisenberger, of Culver, asked how many letters it was advisable to use in grading. There was a variance of opinion as to the best way to mark.

W. S. Tower, district superintendent of schools in Chicago, wondered if physics teachers made a study of the number of students taking physics in the high school. He thought that the teacher should bring the subject to the attention of the student body and show the importance of science in everyday life. He asked, "Do you as a teacher know the per cent of students taking physics today as compared to twenty years ago?"

Mr. Krenerich of Milwaukee stated that he had given ten questions as a test in four different forms. He dislikes the true and false test and thinks that the test in which blanks are left to fill in is the only efficient type of standardized test.

There was a general discussion of the methods used in scoring tests, the opinion of how to eliminate guesswork varying with the individual. The meeting was of great interest and value to all who attended. HAROLD H. METCALF, Sec.

REPORT OF THE NINETY-SEVENTH MEETING OF THE NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS—TENTH MEETING OF THE WESTERN DIVISION.

The Chemistry Teachers' Club of New York City and the New Haven Section of the American Chemical Society joined with the

Western Division of the New England Association of Chemistry Teachers in an all day meeting at the Bridgeport, Conn., Central High School on Saturday, December 5, 1925.

Much of the forenoon was spent in visiting the Bridgeport Brass Co. and the Remington Arms Co. On return to the school, Superintendent of Schools, Carroll R. Reed, very cordially welcomed the Association and friends to Bridgeport and had the new $1,600,000 Warren G. Harding High School Building opened for inspection. This building is very efficiently equipped in the Chemistry Department.

Professor Stuart R. Brinkley of Yale University gave a very instructive talk on "How to Teach the Electronic Theory" which was illustrated with several applications of the theory to oxidation and reduction.

After lunch Professor James Kendall of Columbia University delightfully gave a talk on "The Rare Earths, with Specimens and Demonstrations." Professor S. R. Powers presented a paper on "A Summary of Two Recent Investigations Relating to the Overlapping of High School and College Chemistry" and told of work done at Teachers College under his direction. Mr. Henry S. Johnson of the New Haven High School and Captain in the Officers' Reserve Corp of the Chemical Warfare Service, spoke on "Chemical Warfare, a More Humane Method of Fighting," "The Relation of Chemical Warfare to National Defense."

At the business meeting, members were urged to subscribe to the Journal of Chemical Education through the Secretary as the Association receives thirty cents on each subscription. Copies of the Journal were distributed. The Western Division adopted the amendment to the constitution to change the date of the election of officers from the November to the May meeting. Committees of the Western Division for the coming year were appointed and four associate members elected.

After a sumptuous dinner, Professor Neil E. Gordon, Editor of the Journal of Chemical Education, spoke on "The Goal of Chemical Education." Following this the usual appreciation was expressed and the meeting adjourned.

JOHN H. CARD, Secretary, N. E. A. C. T.

UNIVERSITY OF BRITISH COLUMBIA IN NEW HOME.

A brilliant future is predicted for the University of British Columbia, now that it is "done with tents and hovels" and is in possession of its superb new plant at Point Grey, states Ernest L. Harris, American consul general at Vancouver, in a report quoted in School Life, a publication of the Interior Department, Bureau of Education. The university was established by the provincial legislature of British Columbia in 1890 and began its corporate existence in 1915. It is an integral part of the educational system of the Province, and, as its calendar states, its policy is to promote education in general, and specifically to serve its constituency by teaching, research, and extension work. The new buildings were formally opened September 22, 1925. They are of granite, of a modified Gothic style, and are handsome and dignified. The site overlooks the Gulf of Georgia near Vancouver, and an impressive mountain range gives it an imposing background.

Because of its proximity to American universities and the ease of communication with them, it is probable the relations of the new university with American institutions will be closer than with other Canadian universities.—*Department of Interior.*

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

The ninety-sixth meeting of the New England Association of Chemistry Teachers was held at Wheaton College, Norton, Mass., on Saturday, November 14, 1925, with a large attendance. President Johnson presided.

At 10:00 a. m. Dr. George T. Smart, Acting President of Wheaton College, very cordially welcomed the Association and friends to Wheaton and gave a brief history of the College and its policy.

Professor Glen A. Shook, Head of the Physics Department of Wheaton, demonstrated a very efficient colorimeter and told how it could be easily made at small cost as compared with similar apparatus on the market.

Mr. Irving H. Upton of the Roxbury, Mass., High School, opened a symposium on the place and value of tests and examinations in high school chemistry. He spoke of the value of tests as a means of measurement, for inspiration and correlation. This was followed by a general discussion during which the various types of tests and examinations were taken up.

Professor A. L. Pouleur, Head of the Chemistry Department at Wheaton, gave a demonstration on making ferrous hydroxide and discussed methods of getting this substance pure and tests and uses for the product.

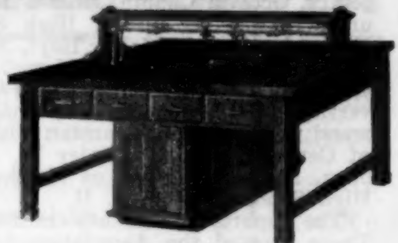
Mr. Shipley W. Ricker of the Woburn, Mass., High School spoke on chemistry for boys and girls. He told about his method of having the pupils review various chemistry books during the year.

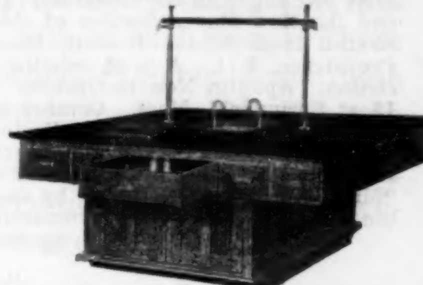
Eleanor Green and Dorothy Brace, senior student assistants in the department of chemistry at Wheaton, very effectively reported on the course given by the Chemical Foundation at the Chemical Exposition at New York. The speakers represented Wheaton College at the course and have the distinction of being the first to represent a woman's college at such a meeting.

At the business meeting eleven new members were elected and the standing committees of the Central Division of the Association reported. Mr. McColley, of the New Apparatus Committee, showed several pieces of new apparatus that Mr. Parker of the L. E. Knott Co. brought. Mr. McColley also told simple methods of making artificial parchment or amyloid, vulcanized fiber, glass marking ink, H_2S, etc. Mr. Churchill of Eimer & Amend was present with a supply of the new Chemrules which were distributed. Mr. Alban Fowler of the Current Events Committee reported on many recent articles of interest to chemistry teachers, among which were transmutation of elements, "dry ice," foamite engines, new elements discovered, etc. "High School Chemistry" by Charles E. Dull, Henry Holt & Co., was reviewed and a copy was circulated among those present. For new business, Miss Patten spoke about a course of popular science lectures for teachers, to be given at M. I. T., commencing in January. All interested in such a course are asked to notify the Secretary of the N. E. A. C. T. or Miss Patten. The Association voted to adopt the A. C. S. Senate of Chemical Education.

Journals of Chemical Education were distributed to those present and were urged to send in their subscriptions, $2.00 annually, to the Secretary of the Association so that the Association may receive 30 cents of each subscription so sent.

Mr. Obear reported for the nominating committee and the following officers were re-elected for the ensuing year: President, Leslie O. Johnson, The High School, Rutland, Vt.; Vice-President, Herbert F. Davison, Brown University, Providence, R. I.; Secretary, John H. Card, English High School, Boston, 18, Mass.; Assistant Sec-





retary, Octavia Chapin, Malden High School, Malden, Mass.; Treasurer, Alfred M. Butler, High School of Practical Arts, Boston, Mass.; Auditor, S. Walter Hoyt, Mechanic Arts High School, Boston, Mass.; Curator, Lyman C. Newell, Boston University, Boston, Mass.; Chairman of Western Division, Charles R. Hoover, Wesleyan University, Middletown, Conn.; Chairman of Southern Division, Raymond R. Thompson, Cranston High School, Auburn, R. I.; Chairman of Central Division, Shipley W. Ricker, Woburn High School, Woburn, Mass.; Chairman of Northern Division, Elwin Damon, Keene High School, Keene, N. H.

The reports of the officers for the preceding year were given. These showed the Association to be prosperous and active. The following meetings were announced for 1925 and 1926: December 5, 1925, at Bridgeport Central High School, Bridgeport, Conn. A joint meeting with the Chemistry Teachers' Club of New York City and the New Haven Section of the A. C. S. February 14, at the Everett High School, Everett, Mass. March at Brown University, Providence, R. I. A joint meeting with the Brown Teachers' Association. April in New Hampshire. May 1 at Boston College. May 15 at Springfield, Mass. October in Maine and Vermont. November at some high school near Boston.

After enjoying a splendid lunch in the main dining room at Emerson Hall, the Association attended a special performance of "Much Ado About Nothing" by the Dramatic Association of Wheaton College, given in the gymnasium.

Respectfully,

JOHN H. CARD,
Secretary to the N. E. A. C. T.

BOOK REVIEWS.

High School Chemistry, by Charles E. Dull, Barringer High School, Newark, N. J., and Newark Technical School. 1st Edition pp. xi+577. 13×19.5×2.8 cm. Cloth. 1925. Henry Holt & Co., N. Y.

This new text by the author of "Essentials of Modern Chemistry" has the merit of using, wherever possible, language which should be intelligible to high school pupils. The beginning paragraphs present a rather more attractive prospectus of chemistry than is usually the case with chemistry texts. The order of events is closely what we have become accustomed to and the content, with several exceptions, about what we usually expect in a high school text in general chemistry. The exceptional material includes chapters on colloids, on new materials developed during the war and on radio activity. There are also sections on atomic numbers, on subatomic structure and on isotopes.

The treatment of the Atomic Theory, the Avogadro Law, chemical equations and calculations based on them is brought together in a series of related chapters.

Illustrations are excellent and numerous. The treatment of the metallurgy of iron and steel is notably good. Summaries and sets of questions follow the chapters, which is an excellent plan. High School teachers of chemistry who are considering new adoptions should see this text.

F. B. W.

Junior High School Mathematics, Book I, by George Wentworth, David Eugene Smith, and Joseph Clifton Brown. Revised edition. Pages iv+266. 13.5×19.5 cm. 1925. Price $.92. Ginn & Co., Boston.

This revision has been made with a view to greater simplicity, to more practical applications, and to an increased use of test material.

The first half of the book is devoted to arithmetic and the second half is devoted to intuitive geometry. Both the arithmetic and the geometry are arranged by topics. J. M. K.

Junior Mathematics, Book II, by Ernst R. Breslich, University of Chicago. Pages x+264. 13×19 cm. 1925. The Macmillan Co., New York.

The first three chapters of this book are devoted to the areas and volumes of the simple geometric figures. Formulas for the areas and volumes are derived and used in making computations. The next two chapters are concerned with the use of signed numbers. These are followed by three chapters on linear and quadratic equations. The book concludes with chapters on community arithmetic, methods of computation, supplementary exercises, and tables and formulas for reference. J. M. K.

"Gems and Gem Materials" by Edward Henry Kraus, Ph.D., Sc.D., Professor of Crystallography and Mineralogy and Director of the Mineralogical Laboratory, University of Michigan, and Edward Fuller Holden, Ph.D., late Instructor in Mineralogy, University of Michigan. First Edition Illustrated 16×23×2.5 cm. Cloth. McGraw-Hill Book Co., Inc., New York. $3.

In this new gem book we find the ripe experience of one who has long known and loved Nature's most precious minerals together with the helpful product of a younger and most brilliant assistant, since, unfortunately, deceased.

For some ten or more years Prof. Kraus has given, at the University of Michigan, a course on Precious Stones, one of the few opportunities in the United States for a formal study of this subject. This book gives to the public a chance to obtain much of what is given in that course.

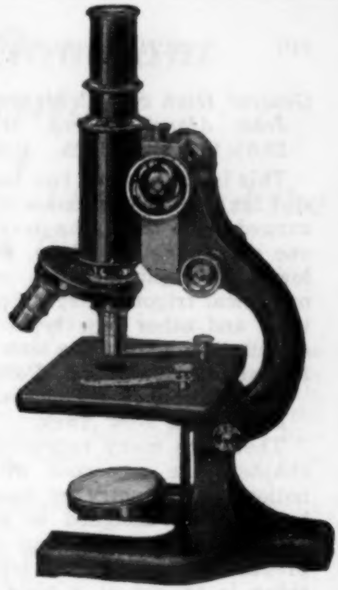
The teacher of physics will find the book a valuable addition to his reference library, for, in the early part there are numerous applications of the physics of light to the problems of the student of gems. Many a boy or girl who finds light uninteresting might be captured by being given a chance to glimpse some of its applications to the identification of precious stones. There is in the first part of the book a good account, in as simple language as possible, of the principles of crystallography and this would be useful to the physiography teacher. The chemistry teacher will find an interesting account of the manufacture of artificial precious stones in chapter IX. The geology class is given a fine synopsis of the processes by means of which we have every reason to suppose most of the gem crystals were produced.

In Part II there is given a detailed description of each of the more important gems together with interesting accounts of sources of supply, etc. Good illustrations of the instruments used in distinguishing gems are supplied and many drawings or photographs of models of crystals are given. There are numerous other illustrations.

Much could be said for the book as a text book for the use of jewelers and as a book of general information for the public but we have stressed here the points that will especially interest teachers of science.

As one who has sat for an all too brief hour in the class of Prof. Kraus the reviewer bespeaks appreciation for his new gem book.

F. B. W.



General High School Mathematics. Book I. David Eugene Smith, John Albert Foberg, William David Reeve. Pages viii+472. 13.5×19.5 cm. 1925. Price $1.60. Ginn & Co., Boston.

This is the first of two books which are intended to furnish material for a two year course in general mathematics. The work is arranged with three chapters on intuitive geometry, one on graphs, one on directed numbers, and one on the formula. These are followed by eight chapters on the traditional algebra, and one on numerical trigonometry. Special attention is given to timed practice tests and other new types of tests which are distributed systematically throughout the text. J. M. K.

Beginners' Geometry. Rolland R. Smith, Newton Classical High School, Newtonville, Mass. Pages xii+327. 13.5×19.5 cm. 1925. Macmillan, New York.

There are many noteworthy features in this text. The first two chapters are concerned with the development of the fundamental notions of geometry by means of the elementary constructions and by exercises designed to give some training in making informal proofs. After completing these chapters the pupil should be well prepared to take up the work of the demonstrative geometry. One thing is taught at a time. For example demonstration is taught in original exercises before it is met with in formal theorems. Difficult theorems are divided into parts which are taught by original exercises. Every new topic is divided into its component parts which are taught separately. The exercises are divided into three groups, developmental, proficiency, and miscellaneous. The developmental exercises are designed to lead up to a statement of a theorem. The proficiency exercises are placed immediately after a theorem and are designed to give the pupil practice in using it. The miscellaneous exercises are to be used by the teacher for any purpose desired.

The book seems to be unusually well written. J. M. K.

A Graphic Table combining Logarithms and Antilogarithms, by Adrien Lacroix and Charles L. Ragot. Pages v+46. 18×25.5 cm. 1925. Macmillan. New York.

There are two logarithmic tables, a five place covering 40 pages and a four place covering 6 pages. These tables are unlike the ordinary tables in that, instead of tabulated figures, a graphic table is constructed with a numerical scale and a logarithmic scale, both having a line in common as a base, and the values of each are represented by graduations placed so that a value on either scale can be read directly in terms of the other, without interpolation. So simple! Why didn't some one think of this long ago? J. M. K.

Elementary and Intermediate Algebra, by Arthur Schultze, revised by William E. Breckenridge. Pages x+461. 13.5×19.5 cm. 1925. Macmillan, New York.

The revision aims to accomplish three things, viz., to retain the strong features of the first edition, to conform to the Report of the National Committee on Mathematical Requirements and to the requirements of the New York State Regents and of the College Entrance Examination Board, and to introduce new material with the purpose of making algebra more interesting to the pupil. J. M. K.

Elementary Algebra, by Arthur Schultze, revised by William E. Breckenridge. Pages ix+334. 13.5×19.5 cm. 1925. Macmillan.

This volume is intended to cover the work of the first year.

J. M. K.

Plane Geometry, by F. Eugene Seymour, Supervisor of Mathematics, New York State Department of Education. Pages xvi+333. 13.5×19 cm. 1925. American Book Co.

The first fifty pages of this book are devoted to intuitive geometry. One of the strong features of the demonstrative geometry is the analytic-synthetic method used in proving propositions. Early in the course the pupil is thrown more or less upon his own resources. The book contains a large number of exercises of which the most important are starred. The typography is excellent. J. M. K.

Information Exercises in Biology by J. L. Cooprider, Central High School, Evansville, Ind. Six sets of exercises are included in one test booklet: (1) completion of sentences, (2) recognition of true and false statements, (3) test of information or knowledge of biological terms, (4) test of reasoning ability, (5) classification of terms, (6) logical selection. Test is put up in packages of twenty-five tests and a direction sheet. Fifty cents a package. Published by Public School Publishing Co., Bloomington, Ill.

That the making of standardized tests in biology has been slow is probably due in part to lack of standardization of subject matter and in part to lack of standardization in method of presentation. Aside from the beneficial results which might come from a general use of information tests, their general use would certainly result in more uniformity in the administration of biology courses in the schools. This test is an excellent start in the right direction. It makes a fair bid for the cooperation of a large body of biology teachers who will use the test in their classes and make a constructive effort to bring biology up to the standard attained by some of the other secondary school subjects in the matter of tests. J. C. I.

Cumulative Mathematics by D. W. Werremeyer, Head of Department of Mathematics, West Technical Six Year High School, Cleveland, Ohio. Published by Harcourt Brace and Company, New York.

Cumulative Mathematics is a three book series, planned for the seventh, the eighth and the ninth years, respectively.

As the title implies, the author has used what he is pleased to call the *cumulative method* of presentation. By means of this method, the habit of forgetting on the part of the pupil is reduced to a minimum in that the pupil is constantly required to use repeatedly every new principle he has learned in all subsequent problem material. Not only is the problem material of each book cumulative as regards the subject matter of that book but the material of the eighth year book and of the ninth year book is cumulative as regards all antecedent material. This particular feature of this series should make a strong appeal to teachers as it has long been the experience of all teachers that the pupils have forgotten much of the material which they have previously learned.

The author appreciates the need for drill in the four fundamental operations with both integral and fractional numbers and has so organized the drill material that the work may be done for several consecutive weeks or distributed throughout the entire term for five or ten minutes daily. Motivation is taken care of by means of introductory concrete problems which show the need for each process taught. At suitable intervals throughout the series, mastery tests, cumulative reviews, and contest exercises have been inserted, the object of which is to secure genuine skill in the essential operations. Every effort has been made to convince the pupil that no computa-

Back numbers of School Science, School Mathematics, and School Science and Mathematics may be held for 35 cents a single. The Mathematical Supplements for 20 cents a copy. In sets, the prices are, postpaid:

School Mathematics and Supplements, Vol. I, five numbers	$1.10
School Science, Vol. I, seven numbers	5.75
School Science, Vols. II, 7 numbers	5.00
School Science, Vol. III, eight numbers	5.50
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School Science and Mathematics, Vols. V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI and XVII, each	2.75
School Science and Mathematics, Vols. XVIII, XIX, XX, XXI, XXII, XXIII and XXIV, each	2.75

tion is complete until he has checked it. Moreover, the author talks to the pupil in language so clear, concise, and succinct that little, if any, help on the part of the teacher is required. This series of books has been written *to* the pupil and *for* the pupil.

The material in the entire series is planned so as to take care of groups of different abilities. The slower groups may omit the starred topics and some of the longer lists of cumulative problems which are graded according to difficulty; the average groups should just cover the text; and the accelerated groups will find sufficient additional work in the supplements.

The Seventh Year Book begins with "An Exercise in Following Directions." Such an exercise as this is sorely needed for the weakness of pupils in this respect is proverbial and the cause of much of the poor work which is done. Work on graphical representation of facts comes early in the book. The pupil learns not only to make graphical records of his grades, of games lost and won, of daily temperatures, etc.; but also to interpret graphs which he finds in the newspapers and magazines. The material offered under "Problems in Everyday Life" emphasizes the *social* uses of mathematics and associates the school work closely with the life of the pupil outside the classroom. The equation method of solving problems is introduced early in the seventh grade. The equation principle of division is the only one used, because it is the only one needed in this year. It has been the experience of many teachers that the pupil likes to use the equation method because it is a shorter method of solving problems. Percentage is not taught by cases. When the pupil has been shown that the per cent sign is used merely to write a fraction in another form; that is to express a fraction as hundredths, then it is clear to him that he may solve all problems in percentage in exactly the same manner as those involving common and decimal fractions. The material on business arithmetic comes within the experience of the child. The problem method of introducing a new topic has been generously used so as to challenge the interest and arouse the reasoning faculty of the pupil. The interrelations between profit and loss, commercial discount and commission have been stressed by means of cumulative problems. The subject of interest grows out of the rent idea. This discussion is followed by some of the simpler and practical phases of banking. By means of an additional list of cumulative problems, the various phases of business arithmetic have been closely interwoven so as to approximate life situations.

The Eighth-Year Book deals primarily with mensurational geometry, community arithmetic, arithmetic of investments, the fundamental operations with *positive* literal numbers, and the simple equation. The aim of the work in the mensurational geometry is to direct the pupil to do his own observing, describing and thinking. Great pains have been taken to develop the topics by the heuristic method. By this method, the pupil discovers for himself the characteristics of lines, surfaces and solids. The classroom, the home and the pupil's surroundings become laboratories for this work. Much emphasis is placed upon scale drawings because, worth while in themselves, they also involve an unconscious review of arithmetic. Realizing that complete comprehension is the first step toward mastery, all formulas are carefully rationalized, so that the pupil may understand the basis for the reasoning in each case. More than ordinary care is taken to imprint indelibly upon the pupil's mind